NUISANCE TO NEMESIS:
NUCLEAR FALLOUT AND INTELLIGENCE AS SECRETS, PROBLEMS, AND LIMITATIONS ON THE ARMS RACE, 1940-1964

BY

MICHAEL R. LEHMAN

DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in History
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2016

Urbana, Illinois

Doctoral Committee:

Professor Lillian Hoddeson, Chair
Professor Kristin Hoganson, Co-Chair
Professor Michael Weissman
Professor Robert Jacobs, Hiroshima City University

Abstract

Fallout sampling and other nuclear intelligence techniques were the most important sources of United States strategic intelligence in the early Cold War. Operated as the Atomic Energy Detection System by a covert Air Force unit known as AFOAT-1, the AEDS detected emissions and analyzed fallout from Soviet nuclear tests, as well as provided quantitative intelligence on the size of the Russian nuclear stockpile. Virtually unknown because the only greater Cold War secret than nuclear weapons was intelligence gathered about them, data on the Soviet threat produced by AFOAT-1 was an extraordinary influence on early National Intelligence Estimates, the rapid growth of the Strategic Air Command, and strategic war plans. Official guidance beginning with the first nuclear test in 1945 otherwise suggested fallout was an insignificant effect of nuclear weapons. Following AFOAT-1's detection of Soviet testing in fall 1949 and against the cautions raised about the problematic nature of higher yield weapons by the General Advisory Committee, the Atomic Energy Commission's top scientific advisers, President Harry Truman ordered the AEC to quickly build these extraordinarily powerful weapons, testing the first in secrecy in November 1952. In spring 1954, the second test of an American thermonuclear (or hydrogen) bomb, CASTLE BRAVO, produced more than 7,000 square miles of potentially lethal fallout deposition near its ground zero, as well as contaminating people and fish in a notorious fallout radiation exposure incident. These tests also produced residual fallout that intensified every spring as it returned from the stratosphere. In April 1954, J. Robert Oppenheimer, formerly scientific director of the Manhattan Project and chair of the AEC's GAC, was permanently stripped of his clearance to handle classified information, ostensibly for failing to display sufficient enthusiasm during development of this weapon. This hearing was effectively a sham that served as a proxy for Air Force efforts to silence his concerns and those of a secret AEC study named GABRIEL, warnings that in the event of war the problematic nature of the cumulative fallout from these weapons would afflict the populations of both the victim and the aggressor as they contaminated the global environment. The transnational public outcry in the years that followed the CASTLE BRAVO fallout incident put intense pressure on political leaders to end testing. The deciding factor at the White House proved to be several instances of fallout contamination of the food supply involving wheat and milk. Tellingly, this was due to the limited fallout from testing alone. This data provided an empirical basis to underwrite earlier cautions that general nuclear war would yield no winner,

only varying degrees of loss. Utilizing the high-altitude capabilities of the U-2, the data that proved the need for caution was provided to researchers by the Air Force. No longer as useful a secret, the military, too, came to see fallout as an issue that unnecessarily problematized their reliance on nuclear weapons. To blunt efforts to achieve a comprehensive test ban, the Air Force pursued underground testing to forestall continuing fallout that would raise deeper questions about the viability of nuclear war itself. Rather than a mere propaganda problem, as it was often seen by officials, fallout proved to be a practical limitation on the use of nuclear weapons. The 1963 Limited Test Ban Treaty that resulted ended most atmospheric testing, but not the possibility that fallout could some day contaminate the planet.

Acknowledgements

In Memoriam

Mark Leff was with this project from the beginning. The subject matter was attractive to him for its compelling public policy dimension. A thorough and thoughtful partisan in the Enola Gay controversy, here Mark clearly hoped more for a good discussion than historical certainty. I think he would have been thrilled to finally find a pretty good effort at both. Thanks for keeping "why is it important?" in front of me. There were few better in any classroom, thus a great loss to every student Mark might have taught that he left us too soon.

Gratitude, Thanks, and Appreciation

To Maiko, whose place in my life gave me a place to live life. Thank you for your immense emotional and material support over many years. Your faith gave me faith in myself.

Lillian Hoddeson could not have been more ideal as my primary adviser throughout the more than decade long genesis of this project. Her grasp of a difficult subject matter was inherent, her patience through my several personal travails exceeded my own, her willingness to stand by the project at even its most discouraging moments was indefatigable, and her gentle urging forward exactly the tone a harried and sometimes embattled researcher needed. I could always count on Lillian for support, expecting me to settle for nothing less than the best I could manage, even when that was often more difficult than it seemed.

Kristin Hoganson's compelling teaching and insightful demeanor were always a helpful and welcome aid to my work. Michael Weissman added an important extra eye on the science and history of physics and its often fraught relationship with the quest for real national security. Robert "Bo" Jacobs stepped in at short notice and long distance to provide the unique insights made possible by living and teaching in Hiroshima along with the exacting perspective of similar research interests. The committee members were supportive, insightful, and gracious in helping me assess the value of my research to the global community for which it is intended. Many others contributed to what I learned here, too numerous to list, except I must mention Jim Barrett, who encouraged me to come aboard and at several difficult moments.

To my father and mother, who supported me again late in life for what I couldn't have done the first time they encouraged my scholarly ambitions. Thank you and my siblings, Dave, Susan, and Greg, who had faith their big brother would come up with something interesting to read. Thanks to Mike Stone, Rosemary Braun, Paul Kennedy, and David Gehrig for being my eager crowd of discussants in helping convince me I figured out some of the secrets of fallout. And thanks to all my many friends and colleagues, inside and out of the History Department and the several other academic units who provided vital support in a timely manner. The Program in Arms Control, Disarmament, and International Security, whose great people always made me feel welcome, taught me much, especially Sharon Ghamari-Tabrizi, who taught me exactly what I needed to know about actor-network theory. Likewise, my colleagues in the interdisciplinary Human Dimensions of Environmental Systems program were a great help in developing and articulating my research. A special thanks to the Library's Government Documents librarians, who were always helpful in obtaining crucial and frequently obscure documents.

Thanks to all my fellow students, undergraduate and graduate, most especially those willing to engage in discussion in too many classes to possibly list. My own students, who were as variable as humans can be, always reminded me of the need to remember the consequential past now in the present if we want a better future.

Our History Department support staff deserves special mention, as their often hidden hand keeps us on track in a supportive environment.

Thank you to Thomas Siebel for support of my research year.

The staff at the Eisenhower and Kennedy Libraries, as well as at NARA College Park, were all helpful and encouraging.

The American Institute of Physics and its Niels Bohr Library welcomed me and were instrumental in aiding me with vital oral history sources, as well as quickly responding to my permission request. The American Meteorological Society was likewise responsive and gracious with permission to use their holdings.

The National Security Archive, in particular William Burr, went the extra mile in helping unearth a couple of key unit histories in their holdings and encouraged me to obtain more, which I did.

The Air Force Technical Applications Center was, as expected, mostly silent, but was responsive and even forwarded me a much appreciated bound copy of their tantalizingly opaque 1997 *Commemorative History*. While this is not the history they would write, I hope they find it useful, too. There's more to say, I'm sure.

Thanks to my several informants, named in the text and anonymous, who made quite useful contributions in every case. I hope this work will inspire others to say what they're

comfortable with, as this is reasonably possible now and once recorded will help others in the future to escape the shadows of doom that the personnel of AFOAT-1/AFTAC have helped hold in check so far. Let’s all wish for further success in preventing those clouds from ever storming on our planet and, perhaps one day, eventually dissipating the fears that underwrite the need for this little-known but absolutely vital organization.

Table of Contents

Acronyms

Note: Names spelled in all capital letters not listed here are code names for various classified projects referred to in the text. A list of Codenames can be found in Appendix F. Aircraft, subordinate unit, and associated unit designations and acronyms can be found in Appendix E.

AAF – Army Air Force

ACDA – Arms Control and Disarmament Agency

AEC – Atomic Energy Commission

AEDS – Atomic Energy Detection System

AEIU – Atomic Energy Intelligence Unit (early British counterpart of AFOAT-1)

AFB – Air Force Base

AFMSW-1 – Air Force Deputy Chief of Staff for Material, Special Weapons Group, Section One

AFOAT-1 – (office routing symbol, before July 1959), Air Force Deputy Chief of Staff for Operations, Atomic Energy Office, Section One

AFSWP – Armed Forces Special Weapons Project

AFTAC – (after July 1959) Air Force Technical Applications Center

ANG – Air National Guard

ANT – actor-network theory

ARPA – (Department of Defense) Advanced Research Projects Agency

AWS – (U.S. Air Force) Air Weather Service

BMEWS – Ballistic Missile Early Warning System

CAE – (Department of Defense, RDB) Committee on Atomic Energy

CEP – Circular Area Probability

CDC – Centers for Disease Control

CIA – Central Intelligence Agency

CIG – Central Intelligence Group

CINCPACFLT – Commander of the Pacific Fleet, U.S. Navy

COMSEC – communications security

CSAF – Chief of Staff, Air Force

CTBT – Comprehensive Test Ban Treaty

CTBTO – Comprehensive Test Ban Treaty Organization

DAC – (AFOAT-1) Data Analysis Center

DASA – Defense Atomic Support Agency

DBM – (AEC) Division of Biology and Medicine

DEFCON – Defense Readiness Condition

DOD – Department of Defense

EMP – Electromagnetic Pulse

EWO – Emergency War Order

FCDA – Federal Civil Defense Administration

FIS – Foreign Intelligence Section

GAC – (Atomic Energy Commission) General Advisory Committee

HASL – (Atomic Energy Commission) Health and Safety Laboratory

HASP – High Altitude Sampling Program

HUAC – House Un-American Activities Committee

HUMINT – human intelligence agents

IAEA – International Atomic Energy Agency

ICBM – Intercontinental Ballistic Missile

IOC – initial operational capability

JAEIC – Joint Atomic Energy Intelligence Committee

JCAE – (U.S. Congress) Joint Committee on Atomic Energy

JCS – Joint Chiefs of Staff

JRDB – Joint Research and Development Board

LASL – Los Alamos Scientific Laboratory

LD50 – Lethal Dose to 50% of a Population

LLNL – Lawrence Livermore National Laboratory (previously UCRL)

LRD – Long Range Detection

LTBT – 1963 Limited Test Ban Treaty, also rendered as Partial Test Ban Treaty (PTBT)

MDR – Mandatory Declassification Review

MED – Manhattan Engineer District

MHA – Murray Hill Area (Project)

MI6 – British Foreign Intelligence

MLC – (AEC) Military Liaison Committee

NAAV – National Association of Atomic Veterans

NARA – (United States) National Archives and Records Administration

NATO – North Atlantic Treaty Organization

NBS – National Bureau of Standards

NCI – National Cancer Institute

NIE – National Intelligence Estimate

NSA – National Security Agency

NSC – National Security Council

NSC 68 – National Security Council Report 68, 14 April 1950

NTM – National Technical Means

NTS – Nevada Test Site

OCB – Operations Coordinating Board

OCDM – Office of Civil Defense Management

ODM – Office of Defense Mobilization

OIC – officer in charge

OL – Operating Location

OSD – Office of the Secretary of Defense

OUA – (Air Force) Outstanding Unit Award

PARPRO – Peacetime Airborne Reconnaissance Program

PPG – Pacific Proving Ground

PSAC – President's Scientific Advisory Committee

R&D – Research and Development

RDB – (Department of Defense) Research and Development Board

SAC – Strategic Air Command

SACEUR – Supreme Allied Commander, Europe

SAM – surface-to-air missile

SAP – Special Access Program

SEO – Special Equipment Operator

SHAPE – Supreme Headquarters Allied Powers Europe

SIOP – Single Integrated Operational Plan

SLBM – Submarine Launched Ballistic Missile

SRW – Strategic Reconnaissance Wing

SRW(L) – Strategic Reconnaissance Wing, Light

SW – Strategic Wing

TAL – Technical Atomic Liaison (post-1954 clandestine British nuclear intelligence unit)

TCP – Technological Capabilities Panel

TRU – Technical Research Unit (post 1954 overt British nuclear intelligence unit)

UCRL – University of California Research Laboratory (later LLNL)

UN – United Nations

USAF – United States Air Force

USSR – Union of Soviet Socialist Republics

WMD – weapon of mass destruction

WRS(VLR) – Weather Reconnaissance Squadron (Very Long Range)

Chapter One: Introduction/Thesis Statement

The objective of this study is to critically examine the significant, if often little understood effects of fallout and other data gleaned from Soviet nuclear weapons production and testing on United States national security policy and strategy as the nation's predominant strategic intelligence sources during the first two decades of the Cold War. The ionizing radiation of fallout revealed vital secrets as an integral by-product of testing nuclear weapons even as it became the subject of intense public controversy in the nineteen-fifties; less well known, but still detectable, were other effects the production and testing of nuclear weapons generated that revealed much about the Soviet stockpile. Fallout became an intractable problem for policy makers, both as an acute threat to human life and as a chronic, fundamentally inescapable limit on the use of nuclear weapons. The focus in fallout's treatment in Cold War historiography has centered primarily on analyzing its narratives as psycho-social studies of fearful public perceptions, yet evidence demonstrates that inside the government ending fallout was a data-driven decision.

The United States Air Force's Fallout Legacy

Fallout sampling and analysis was only one technique among several that served as sources of nuclear intelligence; these included seismology, infrasound, electromagnetic pulse and others adopted from the frontiers of science.[1] Reports on the Soviet nuclear effort generated by Air Force Technical Applications Center (AFTAC) and its predecessor organization, AFOAT-1, played a major, yet largely unexamined role in shaping the strategy, policy, tactics, and force structure of the U.S. Air Force. Buttressed by its invocation of scientific authority and in the absence of more authoritative intelligence about the Soviet Union's nuclear forces, Air Force analysts made worst case scenario interpretations based on this data, disproportionately influencing the first decade of the national intelligence estimate (NIE) process managed by the Central Intelligence Agency (CIA).[2] The Air Force's reporting on its secret, effective, but sometimes flawed use of fallout and other effects generated by fissile material production and weapons testing tended to maximize the Russian threat to engender support for the American

[1] United States Air Force Technical Applications Center, *A Fifty Year History of Long Range Detection, The Creation, Development, and Operation of the United States Atomic Energy Detection System* (Patrick Air Force Base, Florida: Headquarters, AFTAC, September 1997), 57-142.

[2] While "worst case" was my own analysis based on life experience of the default mode of Air Force intelligence analysis, this personal assessment was reinforced by William Burr's virtually identical critique in the National Security Archive's synopsis text of reports posted on the April 1950 Ramey AFB, Puerto Rico Air Force Commanders Conference, Item 3, http://www2.gwu.edu/~nsarchiv/nukevault/special/.

response to it. This established a feedback loop of secret and public information that served as the primary driver of the nuclear arms race.[3] In the process, Air Force analysts distorted the NIE process by faulty assumptions they made about fundamentally accurate data. The global nuclear intelligence network, known as the Atomic Energy Detection System (AEDS) operated by AFOAT-1/AFTAC, eventually proved equally adept at verifying arms control treaty obligations and violations. Although the Air Force resisted diplomacy as an unwelcome limitation on it planning and operational flexibility, most dramatically in serving as among its reasons for hounding Robert Oppenheimer from public service, the intelligence it produced in preparing for war eventually proved at least as efficacious in preventing nuclear war.

Historiography, Evidence, and Argument

Nuclear weapons and intelligence organizations are long-time staple subjects for Cold War historians, yet the potential insights found by treating them as closely linked entities – nuclear intelligence – remain largely unexplored by historians.[4] In large part, this historical gap was a result of continued secrecy restricting availability of source material surrounding the exploitation of the empirical effects of fallout for intelligence purposes and the general sensitivity of any intelligence operations associated with nuclear weapons.[5] Nonetheless, it is

[3] Prompted by secret intelligence findings in reaction to Soviet efforts, the Pentagon then made budget requests to Congress to acquire improved weapons to meet the perceived threat. The Russians then read newspaper accounts in the American open press of the appropriation and acquisition process, leading them to improve their own game, which was then in turned discovered by the West, keeping the unvirtuous cycle of the arms race turning.

[4] A select few monographs published in the last two decades examine specific aspects of nuclear intelligence operations and are discussed in Appendix C as well as cited when they provide essential insights. First among them is the seminal work in the field by Charles A. Zeigler and David Jacobson, *Spying without Spies: Origins of America's Secret Nuclear Surveillance System* (Westport, CT: Praeger, 1995), a history of the development of what became AFOAT-1 up to the detection of Joe-1, the first Soviet test. While this project focuses on the Air Force effort, it also attempts to relate the influence of nuclear intelligence across the spectrum of U.S. national security policy. Providing the best wide view of the role of nuclear intelligence in the larger national security community was written by Jeffrey T. Richelson, *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea* (New York: W.W. Norton, 2006). Additionally, despite a troubled bilateral relationship across many other aspects of the nuclear complex and the Anglophobic AEC Chair, Lewis Strauss, there was a close relationship regarding the tracking of fallout and krypton-85 in particular between the Americans and British. In a field largely to himself so far with British nuclear intelligence was Michael S. Goodman, *Spying on the Nuclear Bear: Anglo-American Intelligence and the Soviet Bomb* (Stanford: Stanford University Press, 2007). All have a special focus and unique limitations. None pursue the policy links between nuclear intelligence and fallout as a problem, despite the intimate connection between these two distinct, yet intertwined topics.

[5] While most classified information is theoretically subject to downgrading and eventual declassification according to its age, this usually does not apply to the topic area of nuclear intelligence. Nuclear weapons-related information is designated as Restricted Data, which is exempt from age-related declassification and controlled by the Atomic Energy Commission and its successor organizations. These declassifications are cataloged in a guide, currently the RDD-8 (Restricted Data Declassification Guide -8) edition, http://fas.org/sgp/othergov/doe/decl/rdd-8.pdf. Other aspects of nuclear intelligence may be classified as Sensitive Compartmented Information or part of a Special Access Program, sometimes regarded unofficially as "above Top Secret" classification. An additional complication

now possible to assemble a critical review of fallout's strategic and policy significance from a composite of sources.

It is important to understand the basis of the Air Force's adjustment of strategy to the perils of fallout was not simply made to save face, but instead was based on facts and data persuasive to the U.S. military, as well as the president and his advisers. Tracing fallout's effects on the national security policy making process provided extensive signs of its influence, including changes in military strategies, choice of weapons and tactics, and an eventual decision to support an end to fallout from the Atomic Energy Commission's testing of nuclear weapons.

Most telling was discovery of the atmosphere's very limited capacity to serve as a buffer against fallout held aloft. Once believed to serve as reservoir or repository, where fallout pumped into the stratosphere by thermonuclear explosions could safely decay before falling to return to the troposphere, by 1959 Air Force U-2 samplers operating in support of the CROWFLIGHT program brought back fallout samples confirming a significant percentage of testing fallout fell back into the troposphere below within the first year.[6] There fallout quickly became subject to the scavenging effects of rainout and gravity bringing it to earth.[7] Additionally, global circulation patterns returning fallout to the troposphere also concentrated its deposition along and roughly five degrees on either side of 45 degrees North latitude, roughly from Portland, Oregon across the upper continental United States through St. Paul to Boston, at rates eight to ten times heavier than it if evenly distributed surface deposition occurred.[8]

---

is that much of the record of relevance here was created prior to the current permutation of SCI and SAP governing regulations and may be grandfathered with unique restrictions into current classification compartments.

[6] Lester Machta, oral history transcript, Nils Bohr Library, American Physical Institute. CROWFLIGHT was an Armed Forces Special Weapons Project program in support of Willard Libby's Project Sunshine at the Atomic Energy Commission. Libby's theory of dispersal and extended residence time that allowed fallout to decay to safer levels was undermined by soil samples indicating accelerated deposition times for global stratospheric fallout, as well as circulation patterns that concentrated its deposition across the United States. The U-2 provided the means to readily access the stratosphere to gain the samples needed to verify with data what was actually happened to fallout at high altitude. Several high altitude shots in the U.S. nuclear program were salted with identifying isotopes to differentiate it in research into detection of nuclear explosions in space

[7] While gravity plays a big role in fallout deposition from the atmosphere, rainout was noticed as a factor in removing fallout from the atmosphere as early as the CROSSROADS BAKER shot (23 kilotons, 24 July 1946). Detonated ninety feet underwater, the huge amount of water the blast vaporized then generated local storms from the resulting condensate, releasing the water as rain that cleansed the atmosphere by bringing much of the fallout with it. The net effect was intense local fallout, which contaminated the test fleet so heavily the scheduled third shot planned for CROSSROADS was cancelled, and very limited success in capturing only weak fallout samples away from the Bikini Island test site.

[8] Lester Machta, oral history transcript, Nils Bohr Library, American Physical Institute. The most intense deposition was along 45 degrees North, but extended on either side of that line by about ten degrees of latitude.

How was it possible to evaluate AFOAT-1's influence on national security policy and decision making with the limited archival record available? Details are often scarce, but the general picture is nonetheless clear once AFOAT-1 is located in its role in the complex web of intelligence and strategy that served the Air Force's military and organizational needs as the service built its strategic forces over its first decade of existence. Information about the Soviet nuclear complex collected by AFOAT-1 was the best available evidence for the Air Force intelligence reports that underwrote the vast expansion of the Strategic Air Command (SAC). The Air Force was an organization driven by a variety of management metrics that measured performance and effectiveness. Following detection of the first Soviet nuclear test in 1949 there were no more important statistic driving the Air Force's own growth than those offered by AFOAT-1's measurement of the growth of the Russian nuclear weapons stockpile. Besides fallout providing qualitative insights into Soviet weapon design, monitoring atmospheric levels of krypton-85 provided the window needed to track and record their plutonium-239 fissile material production with accuracy of within five percent by 1951.[9]

In the case of fallout, it is not hyperbole to argue fallout's role in the history of the U.S. nuclear weapons program and its influence on strategic policy is the most significant remaining largely unexamined factor in Cold War national security history. The material reality of nuclear weapons, because of their potential to create devastating blast and fire effects, seemingly created national security through their capacity to deter attackers. Beginning with Gar Alperovitz's 1965 revisionist examination of the decision to use nuclear weapons on the Japanese, a half-century of debate inside and outside the profession examined that construct and the Cold War strategy and decision making that followed.[10] Buried in secrecy by its role as an intelligence source, the Air Force also saw fallout as an existential threat to SAC, most infamously as the carefully concealed impetus to the 1954 Oppenheimer hearing.[11] Fallout proved to be the central physical constraint

---

[9] Memorandum by R. C. Maude and D.L. Northrup, AFOAT/1, for Mr. Robert LeBaron, Deputy to the Secretary of Defense for Atomic Energy, "Notes on Technical Cooperation with British and Canadians in the Field of Atomic Energy Intelligence," 21 March 1951. http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB7/ae1-1.htm. Appendix B provides an approximation of the amount of fissile material produced annually and thus available for detection. The general trend in techniques used by AFOAT-1 was increased accuracy as methods were refined, but no similar memos for later years has yet surfaced to confirm this was the case with krypton-85 analysis.

[10] Gar Alperovitz, *Atomic Diplomacy: Hiroshima and Potsdam: The Use of the Atomic Bomb and the American Confrontation with Soviet Power* (London: Pluto Press, 1995 edition).

[11] Fallout was not the only source of conflict between Oppenheimer and the Air Force, but it proved to be the only point that was forbidden for witnesses to mention during the hearing itself, even as it clearly was the main point of contention that tied together much of the AEC's shaky case to revoke his security clearance. See Chapter Two.

on the arms race. The story of fallout thus explains how the government went from knowing and ignoring its potential risks to finally eliminating its threat during peacetime by ending atmospheric testing in less than two decades.

Official representations were combined with conventional wisdom about fallout to cultivate the belief fallout was an unanticipated, inconsequential inconvenience. This served to disguise fallout's significant role in the daily routine of national security; in several secret reevaluations of strategy and policy; and in a key role forcing policy makers to confront the multiple constraints it placed on the use of nuclear weapons. While change in national security policy regarding nuclear weapons sometimes came in response to various popular mobilizations against fallout from testing, in fact these policy changes were often significantly catalyzed by secret empirical evidence about the risks it posed. Already knowledgeable about fallout's use for intelligence purposes and its threat when used in war from his military service, Dwight Eisenhower confronted a growing body of evidence as president congruent with public opinion on the need for a far more cautionary approach to radiation exposure than atmospheric testing provided. Facts and opinion both forced Eisenhower to act, even as these facts were withheld to prevent their undermining public perceptions of the military utility of nuclear weapons.

This dualistic concept of fallout and bombs as an essentially linked and self-limiting system may at first blush be controversial, especially for revisionist historians who struggled to reintroduce human agency to Cold War narratives of war and peace in order to escape the ruts of commemorative history.[12] Evidence gleaned from fallout's influence on policy and strategy

---

[12] A common conservative theme warns against the influence of revisionist historians in the academy and elsewhere. While a persistently common criticism of history going back to the Greeks, in fact the basis of the profession is constant, informed revision of the current view of the past, otherwise it would quickly fall into the stale Scholasticism of the early Middle Ages. More specifically in the case of United States and international history much of the current iteration of conservative thought on revisionism traces back to reaction to Gar Alperovitz's ground-breaking 1965 *Atomic Diplomacy: Hiroshima and Potsdam: The Use of the Atomic Bomb and the American Confrontation with Soviet Power* (London: Pluto Press, 1995 edition). Alperovitz's conclusions were disturbing, but much of the antipathy was based on his questioning the uses made of air power and nuclear weapons, which had remained largely submerged in secrecy in the first two decades of the nuclear era amid the ideological constraints imposed by the Cold War confrontation. The central cultural example of this tendency was the symbiotic relationship between the Strategic Air Command and Hollywood, most famously in the guise of Jimmy Stewart who was both star of the movie, *Strategic Air Command*, and an Air Force Reserve officer, eventually rising to the rank of Major General. Stewart was also one of the twelve founding members of the Air Force Association. The best example of the persistence of the bomb's cultural capture was the controversy that erupted in 1995 over a planned exhibit of the *Enola Gay*, the B-29 that bombed Hiroshima, at the Smithsonian Institute to commemorate the 50th anniversary of the bombing of Hiroshima and Nagasaki. The Air Force Association led a massive campaign to pressure the Smithsonian to alter the exhibit.
http://www.airforcemag.com/magazinearchive/enolagayarchive/Pages/default.aspx.The American Historical Association pushed back, arguing that such an exhibit required contextualization of the competing views about

demonstrated that governmental response to its effects was at least as much based on empirical phenomenon that sparked a fundamental crisis of strategy as it was a case of official response to mistaken or unreasonably fearful public perceptions.[13] Rather than undermining the agency of human actors, this treatment of fallout actually underlines transnational resistance against nuclear weapons by providing a material basis for those concerns. Fallout meant failure of deterrence held potential for harsh correction, a reminder that fallout acted on both sides of this equation, by its absence and in its presence, on the attacker as on the attacked. Deterrence was not guaranteed by but instead was undermined by nuclear weapons, because understanding fallout's threat tended to encourage hesitancy, rather than certainty about their use. Recognizing the interaction of its empirical effects with socio-political pressures as a significant force affecting national security policy brings the argument about fallout back full circle to reinforce the conclusion any use of nuclear weapons is a highly impractical solution for achieving national security goals in virtually any conflict scenario.

The goal here is not to privilege one class of evidence or mode of interpretation against another, but to shape the narrative in a more holistic way, to reassess the physical world's effects and constraints on human beings and their relationships with nuclear weapons. Evidentiary gaps remain due to persistent security classification, requiring some limited use of hypothesis and measured speculation to cross back and forth between what we know and what still requires identification, confirmation, and contextualization to construct a useful narrative. The goal is to organize what is known through an iterative process to bring into focus areas of inquiry about what remains masked about fallout in the history of nuclear weapons while using this missing narrative to inform the broader context of Cold War history. Like an incomplete spreadsheet, much can be determined from understanding the architecture of formulas by interpreting adjacent evidence that is visible or is suggested exists, even if the exact values forecast in some fields remain occluded. The questions raised are as important as those answered.

Historiographic arguments about the meaning and significance of nuclear weapons suffered from the absence of a reasonably complete contextual understanding of the wide scope

nuclear weapons, rather than reducing it to a sterile and simplistic explanation of the technological triumph that resulted in the destruction of two cities with two bombs. http://www.historians.org/publications-and-directories/perspectives-on-history/december-2003/historians-protest-new-enola-gay-exhibit.

[13] Ellysa Stern Cahoy provides a useful definition of empirical research, describing it thusly. "Empirical research is based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief." (https://www.libraries.psu.edu/psul/researchguides/edupsych/empirical.html) For a more detailed explanation of its use here, see Appendix C.

of fallout's embedment in the military-industrial-scientific-technological complex.[14] A vacuum of facts maintained through the security classification system fostered an intentional misdirection in the archive that disguised fallout's critical role in Cold War intelligence and national security policy, leading to a historical focus on individual and social perceptions and beliefs about fallout as the means to gain a critical perspective on fallout; the nuclear intelligence effort in general was even more obscure. While public anxieties exerted significant political pressure on the United States government, fallout's empirical effects played a far more significant role than previously understood in forcing an end to atmospheric testing.[15] Demobilizing fallout as a major irritant that caused ordinary citizens to involve themselves in geopolitical affairs removed much of the pressure it placed on national security policy that was dependent on nuclear weapons.[16] Initially resisting President Dwight D. Eisenhower's quest for a total ban on testing, historian Robert Jacobs pointed out how important ending fallout became to those in the Pentagon. The military eventually conceded the limits it imposed, even as they sought to preserve nuclear testing by continuing the practice underground for decades after the 1963 Limited Test Ban Treaty (LTBT).[17] The other face of this decision was that it ended access by independent

[14] Benjamin P. Greene, *Eisenhower, Science Advice, and the Nuclear Test Ban Debate, 1945-1963* (Stanford: Stanford University Press, 2007), 230-232. Green argued the military-industrial- scientific-technological complex was a more accurate description of the more often remembered military-industrial complex mentioned as of great concern and frustration by President Dwight Eisenhower in his valedictory 1961 speech to Congress.

[15] By empirical effects, the repeated expressions by the United States government of fallout's innocuous nature and its rejection of "emotional" reactions to fallout extended throughout the era of atmospheric testing and beyond, suggesting that changes it made in policy and practice should be taken at face value as not attributable to public opinion. Thus, changes in policy attributable in some form or fashion to fallout should be attributed as empirical effects, under the presumption the government has substantive evidence that obligated it to act, whether explicitly or implicitly, to modify or redirect practices and policy under its control. Official and other government reaction to fallout in the form of policy change and other manifestations that serve "in effect" as policy thus should be generally be considered attributable to concrete factors, even when in some cases they appeared to take subjective expressions of public concern into account. These empirical factors also include the direct effects of radiation exposures from fallout, although these have been surprisingly poorly documented in the public record so far.

[16] Lawrence S. Wittner, *Resisting the Bomb: A History of the World Nuclear Disarmament Movement 1954-1970* (Stanford: Stanford University Press, 1997), 439-441, 442-465. Wittner argued that disinterest in disarmament, despite the success of the 1963 LTBT in the decade after its signing "was a central irony" of movements to resist nuclear weapons. Primarily, he attributed the decline in organized resistance to nuclear weapons to a variety of organizational issues. In summing up, Wittner argued that traditional scholarship focused too much on nuclear testing, with it serving as an analogue for people uncomfortable with the idea of actually resisting nuclear war and the horrors it magnified. Here the argument draws an unavoidable direct line from testing to war, but along the way encounters what it hopes are the useful tools for activists and citizens to conduct their own nuclear narratives with greater confidence.

[17] Robert Jacobs, *The Dragon's Tail: Americans Face the Atomic Age* (Amherst: University of Massachusetts Press, 2010), 1-11, 84-98, 120-121. Jacobs draws a direct line from the end of fallout to the apparent slackening of motivation to anti-nuclear activism among Americans. Given that most Americans were far more likely to confront fallout in their paper or on television than they ever were to encounter a nuclear activist, this suggests a cultural

researchers to new fallout and the evidence it provided. Fallout was the binder for this testing-related oppositional cultural formation, yet factual information about it was surprisingly scarce as political resistance to it faded away just as independent civilian research began to study its effects. Public communication and civil defense programs about fallout, which could be charitably characterized as more likely to reassure in the present than to be useful under nuclear attack, also quickly withered as if the conceptual threat faded, the empirical risk should, too.[18] The problem of public fallout anxiety might have been solved for policy makers, but fallout remains a problem while nuclear weapons remain.

Missing Evidence

The shadowy absence of fallout from a significant role in many Cold War nuclear narratives was intentional; illumination of the far more complex role it played in the history of nuclear weapons presents a significantly different account than what was described to the public about it and the threat posed by the Soviet Union. Fallout and associated nuclear intelligence capabilities form a meta-narrative that synergizes what is known about nuclear weapons with what has remained intentionally vague or unknown. Unpacking fallout's history here seeks to improve an existing network of narratives by amplifying themes that convey the meaning of the past more effectively, especially one so consequential as the problem of nuclear weapons, rather than to suggest the wholesale overthrow of what was known about it to this point.

Empiricism ultimately guided the decision to end fallout, in the process shifting the emphasis of American intelligence efforts away from their too narrow field of strategic vision focused on nuclear weapons. The wisdom of Eisenhower's seemingly abrupt decision to let fallout fade away instead of adding to it was reinforced during the brief but intense resumption of atmospheric testing early in John F. Kennedy's presidency. The decision to end atmospheric

---

explanation is at least as likely as a political explanation for a waning of efforts to control nuclear weapons. Jacobs argued the narrative culture of the Cold War could be divided into what came before 1963 and what came after.

[18] Andrew D. Grossman, *Neither Dead nor Red: Civilian Defense and American Political Development during the Early Cold War* (New York: Routledge, 2001), xiii; Elaine Tyler May, *Homeward Bound: Americans Families in the Cold War Era* (New York: Basic Books, 1988), 80-99. Grossman argued that Tyler May's chapter on civil defense amounted to the "silliness approach" to civil defense that "misses the point" of why the program existed, which was how best "to manage and shape *how* the polity viewed nuclear war." In arguing the importance of this political question, he ironically undermined his argument that Tyler May was ignoring the "serious business" of the Cold War by defining its goal as primarily about propagandizing the public, rather than protecting them. Guy Oakes, *The Imaginary War: Civil Defense and American Cold War Culture* (New York: Oxford University Press, 1994), 152-153. Oakes summed up the problem by noting that civil defense measures were ultimately "self-defeating" in that no "exercise of managerial rationality" could overcome "the problems created by radioactive contamination [that] were neither manageable nor even predictable."

testing represented a sudden reversal by the Air Force, fallout's most stubborn supporter to that point. This followed the service's role in forcing out on trumped-up charges J. Robert Oppenheimer, the scientific director of the Manhattan Project, from his subsequent post as chair of the General Advisory Committee, the top science advisers to the Atomic Energy Commission. Ironically, the Air Force's decision to support an end to fallout from testing was motivated by the very same need that earlier caused it to hound Oppenheimer from government service: it sought to insulate its nuclear forces against the political erosion that might arise from critical scientific narratives that fallout made possible. The Air Force feared the potential for a fallout debate to condense around the sheer impracticality of fighting a war resulting in thousands of megatons of thermonuclear yield, a conflict the evidence strongly suggests Oppenheimer was unwilling to walk away from, ultimately at the cost of his career. Sending Oppenheimer into a silent, forced retirement was an attempt by the military to solve what they believed was a perception problem, but data subsequently proved fallout's threat was all too real.

What Is at Stake

The primary arguments of this project revolve around fallout serving consecutively, then simultaneously, as a secret, a problem and a limitation on the Cold War nuclear arms race. While "the Bomb" exerted a broad range of influences on the ways people saw and interacted with its brooding image and potential to interrupt postwar life, it was its invisible, inevitable fallout stubbornly exerting its influence that made it the primary defining factor in how people conceptualized nuclear weapons, even though this influence was often reduced to a narrative of subjectivity.[19] Evidence of fallout's empirical effects remains incomplete, because much of the best data available on fallout remains classified in custody of the U.S. Air Force. Recent declassifications, such as the substantially complete transcript of the 1954 Oppenheimer hearing, facilitate evaluation of the mostly unsung strategic significance of fallout and nuclear intelligence in Cold War history.

---

[19] Spencer Weart's specific impetus to this project has already been mentioned. Also see Paul Boyer, *Fallout: A Historian Reflects on America's Half-Century Encounter with Nuclear Weapons* (Columbus: Ohio State University Press, 1998). Boyer recounts the difficulty of connecting today's students with a recent past ("You Must Keep Reminding Us") when even simply describing recent history in context (the conflict at the Smithsonian over the 1995 Enola Gay exhibit) can prove controversial. Recasting the subjective approach by noting how it was used to minimize perceptions or risk associated with fallout and other radiation, Robert Jacobs argued "that the divide between a physiological and a psychological relationship to nuclear weapons and radiation is at the core of subsequent nuclear discourse, and that a technopolitical dynamic can be discerned in the use of psychological discourse to dismiss public anxiety about radiation and nuclear technologies." Robert Jacobs, Hiroshima Peace Institute, http://bojacobs.net/Bo_Jacobs/Projects.html.

As a secret, fallout served as the most vital and productive source of qualitative intelligence available on the Soviet Union's most worrisome military capabilities in the first decade of the Cold War. It was equaled only by a parallel quantitative intelligence effort to track Soviet plutonium-239 production to determine Soviet fissile material inventories. Measurement of krypton-85, a radioactive indicator cryogenically processed from the atmosphere, tracked plutonium-239 fissile material production within the Soviet Union. Samples captured from Soviet test shots provided running inventories of the qualities and quantities of Soviet nuclear weapons.[20] AFOAT-1 successfully detected the first Soviet test, termed Joe-1 (29 August 1949, 22 kilotons) and virtually every subsequent test until testing largely ended in 1992.[21] Both qualitative and quantitative in nature, inherently accurate, and conferring unusually persuasive scientific authority, the intelligence data produced by AFOAT-1 provided the essential evidentiary premise for the massive build-up of the Air Force's Strategic Air Command (SAC), the most powerful military force ever assembled, if sheer explosive force at its disposal was the yardstick. Fallout shaped the Cold War Air Force, while simultaneously undermining the premise of the service's power – thermonuclear weapons.

The argument here problematizes both the secret national security policy decisions facilitated by fallout in the early Cold War and the effects of this on policy makers in dealing with popular reaction to nuclear weapons and their fallout. While consequential external political forces mobilized by the fears of millions across the globe had significant political effects on nuclear weapons policy, a wide range of empirical evidence secretly demonstrated fallout forced the U.S. military to come to terms internally with the inherent limitations fallout placed on the use of nuclear weapons. At the same time it became a limitation on the arms race, fallout served as a globalized focal point for those opposed to nuclear weapons. Evidence of the political, social, and cultural effects of opposition to fallout on U.S. national security policy was extensive, even when it was not always successful in altering it, as Lawrence Wittner so eloquently and thoroughly treated in his three-volume work.[22] Popular mobilization engendered by fallout was

[20] See Appendix A for basic information on the use of isotopes for intelligence purposes. Plutonium-239 is the favored fissile material used to fuel nuclear weapons.

[21] The declared nuclear weapons states entered an indefinite, informal moratorium on testing in 1992 as part of the wind-down from the end of the Cold War. Since that time, India, Pakistan, and North Korea have all tested nuclear devices at least once. In every case, these tests were conducted underground to minimize, but not eliminate the escape of fallout from the test cavity.

[22] Lawrence S. Wittner, *One World or None: A History of the World Nuclear Disarmament Movement through 1953* (Stanford: Stanford University Press, 1993); *Resisting the Bomb: A History of the World Nuclear Disarmament*

effective in influencing policy change, not because of the numbers of votes opponents might cast – far more people globally opposed nuclear fallout than lived as voting citizens in the United States, with such concerns being closely tracked by the Operations Coordinating Board under Dwight Eisenhower – but precisely because the concerns people across the globe publicly voiced were reinforced by the preponderance of disturbing secret fallout data accumulating on President Eisenhower's desk over the course of his presidency.[23] Facing down public opinion is not uncommon for the executive, even in a democracy, but Eisenhower recognized ignoring public opinion in the face of fallout's barrage of empirical constraints and factual determinations was an untenable position.

In the context of his "lessons learned" speech on the perils to democracy posed by the military-industrial complex, Eisenhower's 1961 warning of its danger to American democracy was an eerie echo of J. Robert Oppenheimer's muffled 1950 plea for enough openness on nuclear matters so that a fully informed citizenry could have input on vital national security policy decisions.[24] Oppenheimer's complaint was virtually all that escaped from Harry Truman's order of silence on any public discussion about the nation's secret pursuit of thermonuclear weapons once he made the decision to do so against the scientific advice of the Atomic Energy Commission's General Advisory Committee following the detection of Joe-1.[25] The vital thread connecting the scientist's interview and the president's speech a decade apart was fallout.

Fallout's limits on the use of nuclear weapons did not arise from the design or efficiency of individual weapons, although it was possible to significantly reduce fallout by changes made

---

Movement 1954-1970 (Stanford: Stanford University Press, 1997*); Toward Nuclear Abolition: A History of the World Nuclear Disarmament Movement 1971 to the Present* (Stanford: Stanford University Press, 2003).

[23] David G. Haight, "Nuclear Testing: A Guide to Historical Holdings in the Dwight D. Eisenhower Library," Eisenhower Library, collection guide. OCB records are among those identified in Haight's extraordinarily useful booklet, which is apparently not on line. A companion guide that is more widely inclusive of OCB records, "Propaganda, Information, and Psychological Warfare: Cold War and Hot," also authored by Haight is available electronically, http://www.eisenhower.archives.gov/research/subject_guides/pdf/Propaganda_Psychological_Warfare.pdf.

[24] J. Robert Oppenheimer, 12 February 1950, radio show interview with Eleanor Roosevelt, reproduced in U.S. Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer: Transcript of Hearing before Personnel Security Board and Texts of Principal Documents and Letters*, Forward by Phillip M. Stern (Cambridge: MIT Press, 1971), 962. Truman ordered public silence from those involved in carrying out his order to rapidly pursue thermonuclear weapons. Since there was no way to discuss the problem without violating Truman's order, Oppenheimer chose to comment about the need for an informed citizenry as essential in implementing policy decisions in the nuclear age. While the scale of intended physical destruction by blast and fire in SAC's war plan was certainly a worthy topic for such discussion, the circumstances again tie this line of commentary to what was not yet widely known about thermonuclear nuclear weapons, which was in fact secret at the time, fallout.

[25] See Chapter 2. The GAC was chaired by Oppenheimer.

in weapon design or by careful use of set tactics of battlefield employment in order to minimize fallout.[26] The cumulative threat of fallout in a nuclear war, given Air Force plans for massed use of nuclear weapons against hardened targets, created both a scenario likely to produce maximum fallout effects and an insatiable demand for fissile material from the AEC to accomplish the task. Calling it the "goddamnedest thing" he ever saw, Oppenheimer was shocked by a briefing on General Curtis LeMay's early plans for thermonuclear warfare.[27] Oppenheimer's reaction to LeMay's plans at this meeting was last straw for an Air Force leadership that long harbored suspicions about his political reliability. Their decision to act against him for his demonstrable lack of enthusiasm for their plans stemmed from this confrontation over the fallout issue, which evidence in Chapter Three will argue took root in the late 1949 conflict over development of thermonuclear weapons between the Air Force, Oppenheimer and the Atomic Energy Commission's General Advisory Committee he chaired until 1952.

Robert Oppenheimer was also among the first to realize the Air Force's development of nuclear intelligence techniques proved verification capabilities that made arms control

---

[26] Reduction of fallout through design and tactical employment had significant effects. In both cases, failure to ensure the fireball from the shot did not touch the ground tended to defeat these efforts because such contact greatly increased fallout production regardless of weapon design. In the fog of war and haste of combat, especially under conditions of nuclear war where targets might be dug in, such fallout-rich deviations from directives might become common. Manuals on basic employment of nuclear weapons, while suggesting low-fallout options as optimal, contained tables and calculations making students aware weapons could be operated outside the designated parameters based on authority from combat commanders. See Department of the Army, *Atomic Weapons Employment, No. 39-1* (Washington, USGPO, June 1956), 25-28, 39, Particularly telling were tables of calculation for casualties and damage according to burst height, in which the designated lowest burst height was typically zero in tables that give a range of choices from high air bursts which "precludes fallout" to impact bursts clearly marked as "produces fallout." Department of the Army, *Staff Officers Field Manual: Nuclear Weapons Employment, FM 101-31-3*, (Washington: USGPO, Department of the Army, 1963).

[27] Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Knopf, 2005), 444. Bird and Sherwin citing Freeman Dyson, *Weapons and Hope* (New York: Harper-Collins, 1985), 137, wrote, "For his part, Oppenheimer questioned the sanity of the Air Force's leadership. He was appalled by their murderous schemes. In 1951, he was shown the Air Force's strategic war plan – which called for the obliteration of Soviet cities on a scale that shocked him. It was a war plan of criminal genocide. 'That was the goddamnedest thing I ever saw,' he later told Freeman Dyson." As argued here, in light of World War Two's redefinition of the nature of strategic bombing, including that conducted with fission weapons, as not in and of itself genocide, it was arguable that Oppenheimer specifically intended to refer to fallout as the characteristic that set apart and identified the war plans utilizing thermonuclear weapons as genocidal to him – except that he could not given its status as a secret. We know from Patricia McMillan, *The Ruin of J. Robert Oppenheimer and the Birth of the Modern Arms Race* (New York: Viking, 2005), 152, the Air Force suspended Oppenheimer's clearance as early as May 1951. If we assume the proximate cause was his reaction to the meeting he described to Dyson, this places it sometime between January and early May 1951. This would have been at a time when the Air Force was eager to know more about the next Soviet test, still months away in September 1951, was eagerly applying the insights gained from monitoring krypton-85 and was eager to ramp up fissile material production, all of which Oppenheimer was intimately involved with. The centrality of fallout to this narrative is also essential in explaining the lengthy period over which Oppenheimer was said to have lost his clearance. Details in Chapter 2.

agreements feasible. However, the combination of his cautions about the dangers posed by the copious amounts of fallout thermonuclear weapons would generate with the idea that such a vital intelligence system would be devoted to pursuit of arms control served only to goad into action those who helped purge him from government service in 1954.[28] Fallout fundamentally limited the arms race because it imposed finite limits of tolerance for the use of nuclear weapons on a military command structure otherwise enthralled by the possibilities of unlimited destructive power inherent in thermonuclear weapons.

Utility of Fallout as a Secret

In the immediate aftermath of World War Two amid concerns other nations would soon undertake their own nuclear weapons programs breaking the American nuclear monopoly, a 12 August 1946 memorandum written by General Curtis LeMay argued that the Air Force was best equipped to develop a nuclear intelligence capability.[29] Like many others busy readying the old Army Air Force to transition into a co-equal, independent Air Force within a unified Department of Defense, LeMay assumed that the Soviet Union was intent on acquiring nuclear weapons, creating an urgent need for a system to detect what the Air Force saw as the eventuality Stalin or his successors would do so.[30] In 1947, on the eve of the Air Force's independence from the Army, LeMay authored a second memo for signature by the Army Chief of Staff, General Dwight Eisenhower, assigning the nuclear intelligence mission to the new Air Force.[31] LeMay later commanded the Strategic Air Command (SAC) as the Air Force implemented the resulting

---

[28] Bird and Sherwin, *American Prometheus*, 449. "Oppenheimer…was intrigued when Vannevar Bush suggested that before this threshold [thermonuclear weapons] was crossed, perhaps Washington and Moscow should agree to a complete ban on the testing of any thermonuclear devices. Such a treaty would require no inspections, since any violation of the ban would immediately be detected." While Bush and Oppenheimer were quite familiar with this concept due to their work in creating and nurturing AFOAT-1, like many Cold War historians Bird and Sherwin were largely unfamiliar with the significant role it was playing in the conflict between Oppenheimer and the Air Force, nor of the extent of the influence of the data on American national intelligence estimates of Soviet military capabilities.

[29] Charles A. Zeigler and David Jacobson, *Spying without* Spies, 13. 50-51, 72.

[30] Ibid, 145. In the late 1940s when research and development to establish AFOAT-1's first networks was underway, nine percent of the available Department of Defense R&D funds for 1947 were devoted to nuclear intelligence, demonstrating how important this project was to the Pentagon, as well as the Air Force. While the intelligence value of observing all other nuclear programs is obvious, less obvious was the need to log and record any detection of radiation to create a database useful in discriminating fallout and other emissions of the primary intelligence target, the USSR, from other sources.

[31] United States Air Force Technical Applications Center, *A Fifty Year Commemorative History of Long Range Detection*, frontispiece, 2-4. The National Security Act of 1947 gave rise to the CIA and thus structured the postwar American intelligence community, as well as the military services. Assignment of the nuclear intelligence mission to the Air Force reflected the service's significant institutional interest in nuclear weapons and its ownership of the aviation resources necessary to locate and collect potentially useful samples.

plan for a global sampling system, operated by AFOAT-1, to conduct long range detection (LRD) against possible foreign nuclear explosions. After a brief stint as president of Colombia University, in 1953 Eisenhower returned to become LeMay's civilian commander-in-chief.

At the time he wrote the first memo, LeMay's argument was based on the general idea of advancing air power by claiming certain areas of special expertise which land or naval forces were unequipped to conduct. In fact, in a happy coincidence, LeMay stumbled onto the fact that the mobility and spatial area covered by aerial samplers were far superior in effectiveness to ground-based stations at returning usable fallout samples for analysis. The Atomic Energy Commission and, later, the U.S. Public Health Service primarily relied on far less effective collection of fallout at fixed ground stations.[32] This division of scientific labor, prioritizing the use of best practices in fallout's collection for intelligence purposes while saddling scientific needs with decidedly second-tier methods, was a feature of fallout data collection throughout the first two decades of the Cold War. Instances where capture of samples aloft were conducted by the Air Force for scientific purposes, from close-in samples taken at test shots for weapon design diagnostics by the AEC to the CROWFLIGHT high altitude sampling done with the U-2 in the late 1950s, were examples of the service's gatekeeper role to radiologically "hot" fallout.[33]

Many historical treatments of nuclear weapons and national security strategy, when they directly discuss it at all, located fallout as of peripheral relevance, its effects attributed to often irrational perceptions of anxiety and fear.[34] A prime example was Richard Rhodes's *Dark Sun: The Making of the Hydrogen Bomb*, where direct reference to it in the index is all but inscrutable. No listing in the index refers directly to "fallout," "nuclear fallout," "radiation," or other

[32] The Atomic Energy Commission had yet to come into existence at the time of LeMay's first memo in 1946, as it was authorized on 1 August 1946 with Truman's signing of the Atomic Energy Act transferring atomic energy facilities to civilian control on New Year's Day 1947. LeMay's assertions on behalf of the Air Force also represented a claim for retention of uniquely military aspects of nuclear energy within the armed services.

[33] CROWFLIGHT was the code name for the first major sampling mission by the Air Force's only U-2 unit, the 4080th Strategic Reconnaissance Wing (SRW), given its unique high altitude capability likely drove the aircraft's acquisition following the CIA's initial order for its use in photoreconnaissance. Training began even before the plane's arrival. The need to obtain these sample was driven by detection of intensified fallout deposition over the upper Midwest at variance with Willard Libby's theory that fallout dispersed into the stratosphere and was held aloft, allowing most of the intense radiation to decay to safer levels before returning to close contact with the terrestrial environment. While the much of the data collected remains secret, it was apparently instrumental in Eisenhower's decision to end fallout. See Chapter Three for detail.

[34] Weart, *Nuclear Fear*. It is important to clarify fear of fallout, whatever its extent and significance, covered a range of concerns for most individuals during the era of atmospheric testing. Was fallout from testing a threat? What about fallout in wartime? How would children be affected? How do you protect your family? Is there fallout in food? Can I inhale fallout? The answers, even more than a decade after the first nuclear bombs were detonated, were sparse to non-existent for most Americans.

common alternative constructions that sometimes reference it in other works. Rhodes did not ignore fallout completely. Rather, Rhodes tracked the consequences of fallout on strategy and weapons development.[35] Consciously or not, this historiographical approach to fallout tended to replicate questionable official guidance of the Cold War era about its inconsequential nature.

One unique characteristic of fallout was that, even as it served as one of the most vital intelligence secrets of the Cold War, unlike virtually everything else about the American nuclear production and military complex, fallout simply could not be locked away securely. This inability to secure fallout's tell-tale signature allowed the Air Force to exploit it for intelligence purposes. To secure continuing viable use of the technique required pretending fallout was inconsequential in hopes the target of interest continued testing in the atmosphere.[36]

With a fruitful first taste of success and a definite target, the Air Force continued to make discrete, nearly exclusive use of fallout for nuclear intelligence purposes until March 1954, when the CASTLE BRAVO fallout incident called unwanted, simultaneous attention to the Air Force's sensitive intelligence resource and its highest priority weapon program.[37] CASTLE BRAVO (15 megatons, 1 March 1954) was the second thermonuclear test and highest yield test ever conducted by the United States, unexpectedly rained down so thick it fell as a visible white dust of radiated coral sickened the crew of the Japanese fishing vessel, *Fukuryu Maru* (Lucky Dragon), while also causing the emergency evacuation of hundreds of islanders as well as Air Force weather observation personnel. As news of the disturbing events leaked out, Eisenhower's insistence it was a "surprise" seemed nearly as disturbing as the actual results – even as Robert Oppenheimer, the Atomic Energy Commission's leading scientist, was then at the point of being expelled from government service in significant part for warning fallout posed exactly this sort

[35] Richard Rhodes, *Dark Sun: The Making of the Hydrogen Bomb* (New York: Simon & Schuster, 1995), Index. While the "index test" is somewhat superficial, Rhodes was simply a salient example of seeing fallout as a sideshow, rather than as part of the main event. Another major and generally quite useful secondary source here, Campbell Craig's *Destroying the Village: Eisenhower and Thermonuclear War*, is similarly afflicted.

[36] Charles A. Zeigler and David Jacobson, *Spying without* Spies, 49-52, 100, 213. Many including General Curtis LeMay believed nuclear explosions could be readily detected via a general rise in the measured activity in the atmosphere.

[37] This work follows the contemporary terminology conventions used by the military and Atomic Energy Commission in documents. Code names like CASTLE BRAVO are rendered in all-caps. For more on such conventions, see William M Arkin, *Code Name: Deciphering U.S. Military Plans, Programs, and Operations in the 9/11 World* (Hanover, NH: Steerforth Press, 2005). In this case, the test series code name was CASTLE, with the second shot assigned a B-word code name, BRAVO. CASTLE BRAVO took place on 1 March 1954 and Oppenheimer's security hearing began on 12 April 1954. While press reports and news releases provided some overview of the fallout incident before and during the hearing, the AEC did not release a detailed report until early 1955.

of problem. Eisenhower's claim was, at best, an inaccurate statement, given the White House ignored five years of warnings from knowledgeable scientists, including Oppenheimer, about the problematic volume of fallout thermonuclear weapons were likely to generate.

In becoming a problem, fallout grew from a nuisance effect into a one that fundamentally eroded the credibility of nuclear weapons by calling attention to their lack of military utility under all but the most exceptional circumstances. In large part, it was the Air Force's insistence on pursuing large inventories of these high yield thermonuclear weapons that defined the primary problem of general nuclear war – the tremendous volume of fallout suddenly created by the mass employment of such weapons, which would contaminate the atmosphere, land, and water, affecting virtually every life form and ecological niche on Earth.[38] Presuming neither side was able to execute a limited, precise, and conclusive preemptive attack to disable the forces of the other, in order to quickly and successfully terminate hostilities with minimal fallout, the prospect of dangerous levels of cumulative fallout from any extensive or prolonged nuclear conflict threatened victor and victim alike, those who took sides and those who preferred to sit it out.[39] Management of the public's perception of fallout as a problem, rather than seeing fallout itself as the problem, was the focus of efforts by the Atomic Energy Commission to counter what the AEC saw as a largely subjective threat to nuclear testing posed by fallout.[40]

[38] Thermonuclear or fusion weapons can be constructed to produce virtually unlimited yield, which is what made them so attractive to war planners and target committees at SAC. Fission weapons have certain physical limitations on yield. Those yield limits become largely irrelevant once the technological leap to fusion weapons was made, because fission reactions then could be used to trigger non-yield limited fusion weapons. Thermonuclear yields below 1 megaton are possible, but those from high-yield weapons above 1 megaton – roughly 60 times larger than the fission weapons used in Japan near the end of World War Two – generate volumes of fallout that represent a dangerous threat to life even far away from the physical destruction caused near the point of detonation (Ground Zero). The SAC target planner's math of nuclear destruction emphasized significant overkill by using multiple high-yield weapons on a single target, in part to raise the possibility of destruction as close to 100% as possible on a first strike. Generally, after 1960 these became hardened targets, although weapon fusing anticipating the need for ground contact was operationally available by the mid-nineteen-fifties. Such use created maximum potential fallout, regardless of yield or design.

[39] After the first several hundred targets, the sheer numbers of weapons requiring disablement would result in heavy global scale fallout whether or not any weapons were fired in return.

[40] Barton C. Hacker, *Elements of Controversy: The Atomic Energy Commission and Radiation Safety in Nuclear Weapons Testing, 1947-1974* (Berkeley: University of California Press, 1994), 43, 51. Hacker noted that the AEC's 1951 announcement it would closely monitor radiation at the newly opened Nevada Test Site was designed largely to overcome public fears about testing. This representation was undermined by the unannounced fact that the "AEC had no plans for distant monitoring" of fallout that moved off-site.

The independent Air Force was founded in large part based on the viability of nuclear weapons offering the capability of quickly and conclusively settling conflicts.[41] Fallout as a secret sustained this belief, but fallout as a problem limited the utility of nuclear weapons by eroding the certainty of deterrence. Somewhat surprisingly, as documented by Benjamin Greene, it was the Pentagon, with the Air Force's consent, that eventually proposed a compromise to end fallout to Eisenhower, an initiative that spoke volumes about the transformation of fallout from ultimate secret into a resolvable problem from the Air Force's point of view.[42]

First a Problem, Then a Secret

U.S. Air Force General Curtis LeMay and Australian scientist Sir Mark Oliphant were, respectively, the midwives of nuclear intelligence and fallout, of fallout as a secret and fallout as a problem. Their starkly contrasting roles point to how fallout was a material actor that shaped and constrained the choices available to policy makers, yet attention to its exertion of power points more broadly the contingencies of its interactions within networks of social actors.[43] Oliphant and LeMay illustrated how gifted, if flawed, humans reacted to fallout in starkly different ways, laying bare its significance. The two were also indicative of the deep institutional knowledge about fallout existing among scientists and the American military from 1940 until it became an obvious public problem. Fallout may have surprised a largely misinformed public, but it was no surprise to a significant proportion of the scientific and military communities working with it in the course of their duties, many for nearly a decade by 1954.

The years between the ill-fated test and Oppenheimer's security hearing in spring 1954 and the eventual test moratorium in late 1958 proved to be a liminal period, with fallout increasingly recognized as a limitation on the nuclear arms race. The enormous scale of destruction the otherwise conventional explosive and incendiary effects of nuclear weapons offered the essential *military utility* sought by the Air Force's "big-bomb" war planners in the

---

[41] The Air Force's strategic role stands in contrast with the capability of the Army to take and hold ground and the Navy to control the sea lanes. Tactical weapons aside, during the Cold War the Army possessed only a very limited strategic role, but Navy submarines played an increasingly important strategic role. Here the focus will be primarily on the Air Force and nuclear energy, with some relevant Army, CIA and Navy materials from the other services directly related to nuclear intelligence and fallout.

[42] See Chapter 4, 369-375.

[43] Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: The MIT Press, 1987); Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford: Oxford University Press, 2005). Actor-network theory (ANT) was developed by historians of science and technology to analyze how material artifacts play vital roles as *material actors* in social networks, thus it is important to understand how these material realities shape and constrain the choices available to human social actors.

Strategic Air Command.[44] General LeMay objected to the very idea of limits on the conduct of warfare, conventional or nuclear, arguing nuclear weapons provided the only means to deliver a knock-out punch to a nuclear-armed opponent.

> Actually I think it's immoral to use *less* force than necessary, than it is to use *more*. If you use less force, you kill off more of humanity in the long run, because you are merely protracting the struggle.[45]

LeMay remained dismissive of the threat of fallout, a problem he worked around as adroitly as he did moral qualms about the conventional rain of ruin hundreds of B-29 bombers under his command unleashed on Japanese cities in the last year of World War Two.

> The whole purpose of strategic warfare is to destroy the enemy's potential to wage war…Let us not forget how the site of the vanished, eradicated Carthage was sown with salt so that nothing would grow there….Radiation, perhaps?...Anything which will achieve the desired results should be employed.[46]

General LeMay's bluster carried the day in his own eyes, but his later actions in eventually implicitly consenting to end fallout, to be certain grudgingly made, to address the fallout problem ironically were, like his disingenuous comments about fallout's effect on his command post, among the best evidence of fallout's real world effects and the respect it demanded of those who at times seemed to treat it tritely.[47]

While LeMay referred to thermonuclear weapons as "interim" ones on the path to what he hoped were ever greater efficiencies of destruction, their effects fit well with his philosophy

---

[44] Military utility is a broad concept that one source (the Pentagon's Defense Missile Agency) defines thusly. "The military worth of a system performing its mission in a competitive environment, including versatility (or potential) of the system. It is measured against the operational concept, operational effectiveness, safety, security, and cost/worth. Military utility estimates form a rational basis for making management decisions." http://www.expertglossary.com/defense/definition/military-utility/source/dod-missile-defense-agency-glossary-v4. Here a simpler definitional question suffices. Is a weapon useable as well as useful? A useful analogy can be made to another type of weapon of mass destruction, biological weapons. A weaponized disease could be useful in incapacitating or killing an enemy force, but could also infect one's own forces, as well as civilian populations. International norms and provisions aside, such a weapon might be useful, but its use would be questionable.

[45] Curtis LeMay, *Mission with LeMay: My Story*, with MacKinlay Kantor (Garden City, New York: Doubleday & Company, 1965), 382. Obviously, the lingering long term consequences of fallout meant LeMay's plans might have both used more force than necessary and killed off more of humanity.

[46] Ibid, 384, 388. There was a significant temporal problem with LeMay's salt analogy. Salt would have dissolved and washed away after a century or so in a dry climate. If Rome had used radiation, given the long half-lives of problematic isotopes like plutonium-239 (24,110 years) and carbon-14 (5,730~ years), Carthage would still be uninhabitable.

[47] LeMay, *Mission with LeMay*, 442. LeMay often cited the thick walls of a new command post built for SAC's headquarters in Omaha as an example of how easily fallout could be defeated, but the very need to construct the expensive structure belied fallout's supposed lack of consequence.

of delivering destruction on his targets with as much force as he could muster.[48] LeMay's direct role in the Air Force's nuclear intelligence effort was relatively short-lived, if crucially timed and executed. Prior to becoming a highly motivated consumer of intelligence from AFOAT-1 as SAC commander, a unit he also helped create, his memos supported rapid development of Air Force nuclear intelligence capabilities, thus demonstrating an acute awareness of fallout's potential utility. Evidence of just how useful can be found in his subsequent roles as SAC commander, then as Air Force Vice Chief of Staff and finally as Air Force Chief of Staff, the top-ranking military leader of the Air Force. These assignments found him uniquely placed to understand fallout's implications for the Air Force and to take advantage of AFOAT-1's reporting on Soviet nuclear activities. Similar to how radioactive isotopes function in medicine to aid discovery and understanding of natural functions and processes, LeMay serves here as a social tracer to aid in marking the spread of knowledge about fallout, its cultural and social influence, and its effective uses within the Air Force

LeMay provides continuity and cohesion in relating a far-flung, complex story, even if this offers only a partial view of discrete parts of a much wider fallout narrative. In the case of military activities like those involving fallout in the 1940s and 1950s, provable knowledge of indoctrination into fallout's implications for any reason not associated directly with test series operations or civil defense combined with one's social position was an important marker of association with nuclear intelligence operations given efforts to closely control access to such knowledge in accord with the "need to know" principle. Due to extensive efforts to conceal nuclear intelligence operations, the evidence at hand is often sparse; certain individuals return repeatedly with known relationships and interests in this narrative, often accompanied only by sketchy or entirely missing information to better inform historians of their exact views or actions. Prior to what has become known in the last two decades about nuclear intelligence operations, an argument could be sustained that LeMay's dismissive treatment of fallout as a threat was simply his assessment based on the limited state of scientific knowledge available at the time. Once fallout as a secret is factored in, however, LeMay was provably cognizant of its promise. His enthusiastic embrace and promotion of long range detection as an Air Force mission, followed by his service in a position that maximized the benefits the Air Force gained from his use of this information, essentially shoots down the "ignorance theory" of overlooking its threat by

[48] Warren Kozak, *LeMay: The Life and Wars of General Curtis LeMay* (Washington, DC: Regnery, 2009), 302-303.

extensive evidence of fallout's clear-cut military utility for intelligence purposes.[49] Once that is factored in with fallout as a problem where it clearly undermined the military utility of thermonuclear weapons, the stakes over the meaning of fallout, whether or not it represented a limit on the conduct of war itself to LeMay, become clearer.

LeMay's Way

A brief assignment in an unusual post at Wright-Patterson Air Force Base in Ohio was among the most crucial in General LeMay's postwar career. The little remarked upon research and development assignment immediately after the war may have seemed a bit far afield, given he came from a combat command assignment at the XXI Bomber Command on Tinian against Japan, pounding and burning it into submission with waves of conventional B-29 bombers armed with high explosives and incendiaries. However, his subsequent role in the delivery of the nuclear intelligence mission to the nearly independent Air Force made him only the second midwife of fallout. LeMay was there and fully engaged with the issue right at the beginning of fallout's usefulness as a secret.[50] After shepherding the nuclear intelligence mission to the Air Force, LeMay subsequently drew another frontline assignment as Commander, U.S. Air Force, Europe (USAFE), quickly followed by his best known assignment, commander of the Strategic Air Command. His philosophical approach to airpower and nuclear weapons encapsulated the motivations and opportunities for the Air Force to fashion fallout and other data collected for nuclear intelligence to secretly serve in support of SAC's enormous budget requests.

Oliphant at Fallout's Beginning

The Air Force's enthusiastic embrace of fallout for intelligence purposes came about only after science established fallout was a substantive problem. At the birth of fission weapons as a theoretical concept, fallout from a uranium bomb was discussed by refugee physicists Otto Frisch and Rudolf Peierls in the very first calculation published of the resulting reaction and its fission products. In reflecting on two brief papers that Australian physicist Mark Oliphant, the co-discoverer of tritium and nuclear fusion, encouraged Frisch and Peierls to write, Richard

---

[49] This example demonstrates how the concept of military utility applies to things other than weapons. Intelligence sources and methods, along with communications networks, transportation and logistics equipment, etcetera, can also possess or lack military utility. Fallout, in particular, likewise shows how the concept is a relative one. While it facilitated collection of intelligence on Soviet nuclear weapons, fallout greatly constrained the military utility of the weapons that gave birth to it.

[50] Chapter Two discusses LeMay's close involvement with the research and development of long range detection through the testimony of one of his aides in this work, General Roscoe C. "Bim" Wilson, at Robert Oppenheimer's 1954 AEC personnel security hearing.

Rhodes drew on their descriptions to place fallout as akin to a sickly Siamese twin conjoined to the blast effects of such an explosion.[51]

> A byproduct of the explosion – about 20 percent of its energy, they thought – would be radiation, the equivalent of "a hundred tons of radium" that would be "fatal to living beings even a long time after the explosion." Effective protection from the weapon would be "hardly possible."[52]

A second paper, designed as an executive summary of the first, more technical paper laid out the potential consequences of this yet-unnamed radioactive hazard.

> Owing to the spreading of radioactive substances with the wind, the bomb could probably not be used without killing large numbers of civilians and this may make it unsuitable as a weapon for use by this country [United Kingdom].[53]

Rhodes noted Frisch and Peierls presciently recognized "it was already clear to two intelligent observers that nuclear weapons would be weapons of mass destruction against which the only apparent defense would be the deterrent effect of mutual possession."[54] What Rhodes elided was the clarity with which the two also recognized the bomb's radioactive by-products, not yet termed fallout but clearly recognized as a threat. Rhodes missed that Frisch and Peierls saw this proto-fallout as the primary driver of deterrence. Fallout set such weapons apart from conventional ones; this property was directly and intimately connected to deterrence.

> …it must be realized that no shelters are available that would be effective and could be used on a large scale. The most effective reply would be a counter-threat with a similar weapon.[55]

The paper was somewhat pessimistic about the theoretical potential of shelter, but correct that shelter systems eventually were seen as too expensive and politically impractical. After encouraging the pair to compose and circulate the papers, Oliphant added a cover letter making clear "that the whole thing must be taken rather seriously" given the potential for the Germans to

[51] Oliphant was a student of nuclear pioneer Ernest Rutherford, a professor at the University of Birmingham, and worked to develop microwave radiation to make practical development of radar possible. All served as qualifying him to sit on the British MAUD Committee, which predicted in early 1941 that development of nuclear weapons was possible as early as 1943 based on the Frisch and Peierls papers. The MAUD reports were circulated to the Americans, who seemed to ignore them, prompting the British to send Oliphant to the United States. There Oliphant's effort to draw attention to the potential threat was eventually rewarded by creation of the Manhattan Project, as the United States could afford to pursue a project that outmatched British resources.
[52] Richard Rhodes, *The Making of the Atomic Bomb* (New York: Touchstone, 1986), 324.
[53] Ibid, 325.
[54] Ibid, 325.
[55] Richard Rhodes, *The Making of the Atomic Bomb*, 325.

develop such a weapon.[56] The Frisch and Peierls papers, fundamental to the theory of fission weapons, made it absolutely clear fallout would be an inevitable, consequential effect of nuclear weapons, however inconvenient or technically problematic it made their use in warfare.

Oliphant's taciturn scientific remarks show that what became known as fallout was a defined problem area years before the Manhattan Project itself began. Oliphant passed through a wartime experience that included service with the Manhattan Project, but was expelled from it for his supposed lax attention to security. Nonetheless, the fact that he went on to play a key role in facilitating independent fallout research after his postwar return to Australia was an ironic testimony to how the inevitable curiosity of science made the secret use of fallout for intelligence purposes a perishable secret. It was simply too obvious a method to remain concealed indefinitely. The one great nuclear secret beyond government control was also one that any nation or scientist could likewise engage in by monitoring fallout so long as testing in the atmosphere continued to release it into the environment. Oliphant had no ulterior goal in his encouragement of Hedley Marston's fallout research after his return to Australia. Based on similarly mundane scientific principle to facilitate publishing an obviously pertinent set of information, it was certainly informed by intervening events, including the notorious 1954 CASTLE BRAVO incident. By 1957, a locally notable, but otherwise obscure Australian academic, Marston, documented and sought to publish his findings on the spread of fallout from British testing in Australia.[57] Marston's work with iodine-131 demonstrated to the Western

[56] Ibid, 325. In 1941, along with others on the MAUD Committee Oliphant was attempting to simply gain the attention of the British government to the problem this posed when the British were trying to hold the line against the Germans, so the memo framed the problem in terms of the threat such a weapon in German hands represented more than whether the British should pursue the idea given its complexity and the limited resources the British could muster under the circumstances.

[57] Roger Cross, *Fallout: Hedley Marston and the British Bomb Tests in Australia* (Kent Town, South Australia: Wakefield Press, 2001). Cross's book reads like one of those serialized detective novels the BBC lavishly remakes into public media gold, but on a budget. Marston discovered extensive contamination from iodine-131 from British nuclear weapons testing in Australia, despite official denials to the contrary, with the help of state-of-the-art counters provided by the Americans and British. Engaged by the British as part of an effort that contributed to the AEC's GABRIEL study on the risks of cumulative fallout, Marston independently pursued more extensive analysis of the fallout he collected from soil flats by supplementing those findings with thyroid and other specimens collected from his network of pastoralists. "Classified Discussions at Harwell by L.T. Alexander and R.A. Dudley." [undated, but context places it in 1955 for reporting on visit between 31 January and 3 February 1955], NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73. His efforts to publish his findings were intentionally obstructed by the British until the Windscale accident made efforts to suppress his findings superfluous. As it turned out, Marston's primary assigned "handler" when he agreed to help the British in monitoring the testing was the British-Australian scientist Ernest Titterton. Along with William Penney, Titterton remained a favorite of the Americans even when the rest of the nuclear special relationship was falling apart over Klaus Fuchs, Kim Philby, and other security lapses. While ostensibly managing the fallout monitoring effort during

intelligence services that fallout research as a viable field of scientific inquiry would increasingly dog their work so long as atmospheric testing continued. Marston's was not a direct challenge to fallout's use for intelligence purposes, but its exposure of sensitive information gleaned from iodine-131, one of the most useful of all isotopes for intelligence purposes found in fallout, was one of the transnational effects of fallout's international mobility and its sparking rapidly spreading interest and knowledge in nuclear subject areas across the scientific community.

Oliphant was just one among thousands of scientists who served in the Manhattan Project and hardly alone in his misgivings about the outcome. These actions did not go unnoticed by the Air Force as it formed up into an independent service. The formation of RAND Corporation to provide carefully screened scientific consultation was one response, with its first employee, David Griggs, later serving as Air Force Chief Scientist – and apparently being on call virtually the entire time in between to observe J. Robert Oppenheimer as potentially disloyal.[58] Griggs was intimately involved in the Air Force's inquisitional institutional distrust of Oppenheimer, which saw the service play a major role in events leading up to Oppenheimer's 1954 AEC security hearing. Fallout proved on further review to be far more than a tangential subtext in the transcript in light of what is now known about the context of the hearing amid the Air Force's vigorous campaign to discredit and banish Oppenheimer.[59] The Air Force saw those concerned

---

the British Australian test series in the mid-fifties, Titterton was also secretly in command of the British nuclear intelligence effort in Australia, including coordination with the Americans. In 1956, the British collected the samples and delivered them to the U.S. Consul in Perth, who delivered them to a waiting U.S. Air Force Military Air Transport Service C-118 to fly them to AFOAT-1's laboratory at its Western Field Office at McClellan AFB laboratory in California. AFOAT-1, 1956 Unit History, 46-57. Cross provided new insights into the case, reinforcing the belief the British either badly mishandled the scientific effort to evaluate the spread of fallout across Australian—or were simply lying. However, Cross was completely naïve about the intelligence angle involving Titterton, so in addition to drawing the usual conclusion British secrecy was attempting to cover up its embarrassing dirtiness, he ascribed the breakdown in communication between Titterton and Marston as due to Titterton's lack of social graces amid an unseemly deferral to British concerns. As with much about fallout, it was true as far as it went, but the secret bottom line to the story suggested even more sinister implications to the stage-management of public opinion. Marston's effort did put both American and British officials on notice that fallout was no longer much of a secret since by 1956 it threatened to give away nuclear secrets like a drunken spy, not only to the Russians, but to potentially embittered citizens.

[58] Griggs's role in the Oppenheimer affair was extensive and will be discussed in Chapter Two. Griggs was Rand's first employee and General LeMay the first appointee to the Deputy Chief of Air Staff for Research and Development, which Rand reported to, in December 1945.

[59] Despite reminders to witnesses they were bound to keep the proceedings confidential, AEC chair Lewis Strauss ordered a heavily redacted version of the transcript publicly released within months of the 1954 hearing. There was not a single use of the term fallout, but this was not too surprising given the sensitivity of the subject. Sixty years later a nearly complete, declassified copy of the transcript was released. See Office of History and heritage Resources, "J. Robert Oppenheimer Personnel Hearings Transcripts," United States Department of Energy, October 2014, https://www.osti.gov/opennet/hearing.jsp. As Chapter Two relates in analyzing the role of fallout in the full transcript, surprisingly the term fallout remained completely excluded from the 3,000 some pages of testimony,

about fallout as the problem, rather than fallout itself. This willful myopia about fallout on the part of the junior service sustained dead-end policies like its quest for high-yield thermonuclear weapons to provide an expensive, vastly dangerous capability for overkill. Some Air Force leaders even contemplated pre-emptive war based on securing and then using that stark American advantage, views that found expression at the Air Force commanders conference at Ramey Air Force Base, Puerto Rico in April 1950.[60]

Like many other Western scientists uncomfortable with the military's embrace of nuclear weapons, Oliphant avoided direct, public challenges to the bomb-friendly political establishment. The access and prestige held by virtue of his position as founder and first chair of the Australian Academy of Science, among other qualifications, were contingencies serving, along with the quick spread of radiochemical analytical techniques through the scientific community due to Eisenhower's contemporaneous "Atoms for Peace" program, to aid Oliphant's later encouragement of independent research by Marston. The results of Marston's research led to embarrassing revelations about British governmental veracity on fallout when its bomb test organization tried to foist apparently invented data on the Australian public. In themselves, Oliphant's actions, in 1940 and 1956-57 did not directly threaten the work of the Manhattan Project, AFOAT-1 or its British equivalent.[61] However, the results of Oliphant's support of Marston's work demonstrated fallout was a secret too big to hide and already moving quickly toward obsolescence as a source of intelligence by 1957, when the first deep, contained shot RAINIER (1.7 kiloton, 19 September 1957) was triggered nearly 900 feet below ground at the Nevada Test Site (NTS).[62]

What Would LeMay Do?

Opening a window through LeMay's eyes about something he never directly discussed publicly, but certainly utilized, is necessary precisely because this topic was so far off limits that most conversations the general had about it were likely conducted with the expectation they

---

despite passages where various witnesses talk around what they seem to treat as an extraordinarily sensitive topic. The topic of fallout proved too sensitive for the AEC to discuss directly at the hearing.

[60] The conference, held just after promulgation of NCS 68 and just prior to the outbreak of hostilities in Korea, will be discussed in Chapter 1.

[61] Goodman, *Spying on the Nuclear Bear,* 102. Initially known as the Atomic Energy Intelligence Unit (AEIU), after 1954 the British nuclear intelligence organization was known as the Technical Research Unit (TRU, the overt organization) and Technical Atomic Liaison (TAL, the covert organization.)

[62] Several previous shots in close contact with or slightly below ground occurred, but did not attempt full fallout containment, which RAINIER reportedly demonstrated.

would never be publicly disclosed. The question of "What would LeMay do?" frames a window into an otherwise intentionally obscured area of Air Force history during the Cold War. Much as fallout and krypton-85 provided useful tracers that shown a light into the "denied areas" of the Soviet Union for AFOAT-1, LeMay was a leader whose philosophy, opportunities, placement at the scene, and essential interest in the metrics of destruction provided the means to evaluate the value of fallout and nuclear intelligence to the Air Force in 1949, as well as to explain why by 1959 that value eroded to the point where the Air Force concluded fallout was no longer worth the political and military costs, if not the public health burden it imposed on the planet.

While not strictly a numbers game, the Air Force, in general, and SAC, specifically, were numbers-driven organizations. Every small advantage that could be statistically eked out was documented, digested, and discussed by analysts and planners.[63] The details of AFOAT-1's role, while at the present largely undocumented beyond its recently declassified unit histories, were the key, initial part of the answer to the central question of countering the enemy's most powerful capabilities.[64] What were the qualities of Russian weapons and how many did they possess? SAC was built to counter the threat outlined by AFOAT-1's reports on Russian nuclear weapons, so its staff, and General LeMay as its commander, were intimately familiar with the findings in AFOAT-1's reporting on Soviet weapon stockpiles.[65]

The Russian stockpile inventory described by AFOAT-1 was all the more important because nuclear warfare, at best, presented very limited defensive opportunities against attack. The only sure defense was to destroy the opponent's weapon systems "on the launcher" – or better yet, before they arrived there – to prevent their use. In essence, a good defense was only possible with an aggressive offense, creating a use-it-or-lose dynamic that guided SAC war planners toward the massive initial use of thermonuclear weapons that made fallout an intractable problem. AFOAT-1's reports on Soviet plutonium-239 production allowed analysts

---

[63] While he served in the Air Force with AFOAT-1/1009th SWS, the author's father subsequently worked as a "manpower engineer" analyzing human factors through time studies by means of the familiar model of Taylorism, including earning an MBA through the Air Force Institute of Technology (AFIT) to support computer-based analysis of efficient work practices. Such accumulations of modest incremental gains were typical of the Air Force's dogged pursuit of high performance standards.
[64] The NARA facility in College Park, MD also holds a small collection of declassified AFOAT-1 and Project Sunshine documents.
[65] AFOAT-1 worked closely with SAC on a number of issues, most notably its outreach to offer aid to SAC's primary warfighting mission in the case of hostilities. The most salient example was its capability to verify points of detonation of both U.S. and Soviet weapons, which was limited at first but became more accurate as the EMP and seismic systems were improved over the course of the 1950s. See "Warfighting" chapters in the AFOAT-1 1947-1953, 1954, and 1955 unit histories.

to inform SAC of roughly how many weapons it needed to counter and destroy. A major weakness of first generation intelligence collection systems like the AFOAT-1- operated AEDS was its ability to locate targets was limited. That limitation plagued the ability of systems like the AEDS to answer questions the data they produced raised. Questions about the accuracy of the Air Force's conclusions about Soviet strategic forces led to the imagery revolution in intelligence that produced the U-2 and put reconnaissance satellites on the way to the launch pad as the decade drew to a close.

LeMay argued SAC discovered the Soviet Union was weak enough to defeat before anyone else realized it, perhaps as a curious rebuttal to demonstrate he was somehow on top of the bomber and missile "gap" issues before they fell apart publicly as an analytical concoction based largely on pressures to build up SAC. LeMay suggested this would have been opportune time for a preemptive attack, but he claimed the window of opportunity passed quickly and was missed.[66] His real problem was locating targets for his bombers in an age before imagery became available. Because of AFOAT-1's work, LeMay was well-aware of the numbers of Soviet nuclear warheads his bombers needed to destroy, even though it took imagery to resolve that the Soviet Union's capability to deliver them proved far weaker than Air Force analysts believed. These analytical mistakes by the Air Force often are written off as simply SAC's aggrandizing the enormous resources it required, but it was based on accurate and deeply troubling intelligence data, which adds considerable nuance to this aspect of the Cold War confrontation.

The depth of the Air Force's devotion to fallout was recalled in the bitter recriminations that flowed from General Thomas S. Power, Curtis LeMay's successor as SAC commander, after atmospheric testing first ended near the end of 1958 with a temporary moratorium while negotiations for a permanent ban continued in Geneva. Arguing his case in March 1959 to the

[66] LeMay, *Mission with LeMay*, 481. According to LeMay's somewhat hazy retelling, this was the period until the Soviet Union acquired a significant stockpile of weapons. It was also a rather obvious non-reference to the intelligence he received from AFOAT-1's analysis of krypton-85. Since LeMay was vague here about a sensitive subject, consideration of the general trends in plutonium-239 production described in Appendix B is worthwhile. The Soviet cumulative Pu-239 stockpile only exceeded 1,000 kilograms in 1954, then over 2,000 kilograms in 1956 (when the United States cumulative total exceeded 6,000 kilograms), which may have reflected the confidence demonstrated by SAC's 6 May 1956 mass HOMERUN mission described by Peebles. That sort of confidence (or hubris) would have represented the latest date LeMay may have had in mind, as he left SAC to become Air Vice Chief of Staff in mid-1957. Curtis Peebles, *Shadow Flights: America's Secret Air War against the Soviet Union* (Novato, CA: Presidio, 2000), 125-127. Project HOMERUN was a presidentially-approved mission to document Soviet Arctic defenses in late winter and spring 1956. Unlike the typical PARPRO mission, the HOMERUN flights involved deep penetration into Soviet airspace. The most daring climaxed in a provocative mission by a mass flight of RB-47 photo and signals intelligence aircraft that traveled more than a thousand miles through Soviet airspace over eastern Siberia, turning east to Alaska to recover. The results demonstrated the region was lightly defended.

Joint Chiefs of Staff, General Power insisted Americans needed to be offered a stark choice between fallout and insecurity.[67]

> …[T]he JCS should request the Office of the Secretary of Defense (OSD) to launch a campaign to persuade the American people that fallout from nuclear weapons tests was a negligible hazard compared to the peril that would result from failure, through insufficient testing, to maintain an adequate nuclear deterrent.[68]

By 1959, fallout's influence on policy could not be denied. Power's seemingly poorly-timed, retrograde plea was ignored as the Air Force leadership, including his old boss General LeMay, grudgingly chose to free the service of its too close an association with fallout by agreeing to take testing underground. Following ten years of struggle to first hide, then market fallout as a symptom of security, by 1959 Air Force leadership embraced the anxiety of those concerned about fallout by realizing that it could define peace – and effective deterrence – simply by its absence.[69] Thus, the Air Force's shift to support an end to fallout added a starkly realistic mandate to SAC's slogan, "Peace Is Our Profession." It was a decision made easier by the declining intelligence value of a sampling system which by then clearly defined a mature and robust Soviet nuclear program. The incremental value of the intelligence gained versus the capital invested faded with each new test in Kazakhstan or on Novaya Zemlya.

LeMay believed deterrence arose from an enemy's fear of the consequences of war, which he attributed to the physical destruction by blast and fire common to both conventional and nuclear explosives.

> We must have more than enough to deter them. *More* than you *think* is enough to deter them…We started out years ago to build a decisive power tailored around our possession of nuclear weapons…We must keep that overwhelming superiority…It won't come from sitting around and crying *stalemate*…[70]

Arguably, the intentionally public nature of the often bellicose expansion of SAC's destructive capabilities appeared to drive Russian reaction to match American efforts with its

---

[67] While best remembered as an operational commander, Power was also associated with nuclear weapons R&D. Power served as the deputy chief for air at CROSSROADS, and then commanded the Air Research and Development Command in the three years prior to replacing LeMay as SAC commander in July1957.
[68] Bernard Nalty, *The Air Force and Nuclear Testing, 1958-1964,* Washington, DC: USAF Historical Division Liaison Office, 1965.
[69] Chris Adams, *Inside the Cold War: A Cold Warrior's Reflections* (Maxwell AFB, Alabama: Air University, 1999), 78-79. SAC adopted the slogan "Peace Is Our Profession" in 1958, after using the text in the display of a 50-foot Christmas tree in front of its Offutt AFB, Nebraska headquarters in 1957.
[70] LeMay, *Mission with LeMay*, 561-563.

own. Deterrence is a two-way street; failure to compete in such situations was seen as a sign of weakness, a perception LeMay and his Russian counterparts likely shared. While the intelligence justifying it remained secret, basic information on military budget allocations and weapons acquisitions was then published in the West's relatively open press, in effect publicly throwing down the armored gauntlet that formed part of SAC's symbolic shield in front of the Russians.

Another result in the mixed record of LeMay's pursuit of deterrence was to encourage the Russians to expend comparable efforts to present at least a credible response to what they saw as a threatening enclosure by American arms. While deterred from war itself, there seems little to justify the notion the Russians were deterred from preparing for war – or that the net effect of those additional Soviet nuclear weapons somehow increased the national security of the United States. Given the hair-trigger, irrevocable nature of a nuclear-armed missile launch, the thousands of additional Soviet launchers built in response to the vast SAC expansion, itself based on erroneous interpretations of AFOAT-1 data, and the Soviet propensity for bureaucracy to overcome effective control, LeMay's over-the-top build-up of SAC actually undermined national security, leaving the adversaries just one accidental missile launch shy from conclusive proof of that until the end of the Cold War.

Chapter Two: Fallout – Hidden in Plain Sight

How Are the Problems of Long Range Detection and Fallout Related?

In the first decade after its birth in 1945, fallout remained – mostly – a secret. Used for intelligence, the restrictions fallout later placed upon contemplated use of nuclear weapons significantly affected the expected military utility of these otherwise tremendously destructive weapons. In effect, fallout became a self-limiting property of nuclear weapons. Fallout became a significant factor causing rational actors with nuclear arsenals to back away from military confrontation involving these weapons. The limited, but still significant fallout from testing led to adoption of the 1963 Limited Test Ban Treaty (LTBT), the first major arms control initiative of the Cold War.[71] Just fourteen years after the USSR broke the American nuclear monopoly and despite confrontations stretching from Berlin to Cuba and even deep into the heart of the Soviet Union via U-2, a consensus emerged between the Soviet Union, the United Kingdom, and the United States to end fallout created by testing nuclear weapons in the atmosphere.

Fallout and a variety of other radiochemical and geophysical phenomena served to facilitate a secret intelligence mission the Air Force termed *long range detection* (LRD), conducted by a network of systems and techniques collectively called the Atomic Energy Detection System (AEDS).[72] Established as an interim organization in the same year as the independent Air Force, AFOAT-1 was known to those who needed to know simply by its office symbol, although it also used the nearly as arcane 1009th Special Weapons Squadron (1009th SWS) when necessary to identify itself operationally to other military units. Other organizations in the government, primarily the Central Intelligence Agency (CIA), shared responsibility for nuclear intelligence during the Cold War with AFOAT-1, but the AEDS was the primary source of intelligence on the Soviet nuclear program. The Air Force alone among them was unique in devoting vastly more resources to this mission, but as the junior military service it was also the only one existentially dependent on the subject of interest that generated it, nuclear weapons.

---

[71] The 1963 LTBT ended all but underground testing by the three major nuclear powers, the United States, the Soviet Union, and the United Kingdom. Although France and the People's Republic of China intermittently continued the practice of atmospheric testing over several more decades, the three original nuclear powers contributed the vast bulk (~99%) of the cumulative fallout released by Cold War nuclear testing. The last atmospheric test was 16 October 1980 by the People's Republic of China. The LTBT is also referred to as the Partial Test Ban Treaty.

[72] In Air Force operational concepts, long range detection was a set of techniques including fallout sampling distinct from cloud tracking, which involved close-in sampling of test debris in support of AEC requirements.

A sharp disjuncture between the first two decades of fallout's existence was noted by one of the early theoretical strategists of nuclear war and deterrence, Bernard Brodie.[73] Brodie was shocked and taken aback in early 1955 when the U.S. Atomic Energy Commission published its report on the 1954 CASTLE BRAVO/*Lucky Dragon* fallout incident, the most significant and best documented acute radiation exposure of the Cold War.[74] Familiar with many of the early Cold War's most sensitive secrets due to the nature of his work evaluating strategic war plans for the Pentagon, Brodie was nonetheless surprised that the government so openly conceded fallout's now publicly apparent contribution to the "strategic problems" of the day.

> Until two weeks ago, I would have said that there was only one piece of really basic information vital to an appreciation of the strategic problems of the future that was still being withheld – that concerning 'fallout.' Now even that information is in the public domain.[75]

Beyond the negative publicity associated with the CASTLE BRAVO incident, why was fallout's lost secrecy suddenly a problem, given it was produced at numerous other nuclear tests over the course of the previous decade, including at the first and only previous thermonuclear test, the experimental IVY MIKE device (10.4 megaton, 31 October 1952)? Despite his insider knowledge, Brodie's shock on reading the admissions in the CASTLE BRAVO report came about because it was an encounter with something mysterious, yet already around – even possibly *in* him – fallout.

Fallout was far from familiar before 1954. Cultural images depicting the nature of atomic destruction and fire in Japan were common after 1945, yet most of these images depicted a

[73] Barry H. Steiner, *Bernard Brodie and the Foundations of American Nuclear Strategy* (Lawrence: University Press of Kansas, 1991), xi. Described as "a founder of the modern study of…strategy in the nuclear and missile age" Brodie's conclusions "became the paradigm in the analysis of nuclear strategy…our basic idea of deterrence."
[74] National Security Archive, "60th Anniversary of Castle BRAVO Nuclear Test, the Worst Nuclear Test in U.S. History," http://www2.gwu.edu/~nsarchiv/nukevault/ebb459/. Edward Teller made a point of describing the CASTLE BRAVO incident as "the worst accident in the history of U.S. testing," but then went on to ponder what all the fuss was about, since only one person died, by comparing it to Hiroshima and Nagasaki, while disingenuously noting "the Japanese are now in the forefront of nuclear engineering." Edward Teller, *Memoirs: A Twentieth-Century Journey in Science and Politics* (Cambridge, MA: Perseus, 2001), 439.
[75] Bernard Brodie letter to Joseph E. Johnson, 28 February 1955, UCLA Collection, Box 1 [J Folder], cited in Steiner, *Bernard Brodie*, 313-314 (n59). Steiner assessed Brodie's informants on nuclear strategy most likely underestimated the effects of fallout prior to CASTLE BRAVO. Given the secrecy surrounding fallout's use by AFOAT-1 for intelligence purposes recounted here, it is an equally arguable possibility that this information was not passed to Brodie because he lacked the requisite "need to know." With a background in nuclear strategy, regardless of why he was previously ignorant of the implications, he immediately recognized that the extraconventional effects of these weapons, primarily fallout, was as significant as their scaled-up supraconventional effects.

marked similarity to the effects of conventional weapons, emphasizing the vastly increased scope of physical damage created by nuclear weapons.

The virtually unfathomable phenomenon of fallout, a nuclear weapon effect simultaneously far more difficult to communicate visually and subject to a mysterious official opaqueness, provided little basis from which to conjure a compelling graphical image. Spencer Weart's theoretical approach in his 1986 *Nuclear Fear: A History of Images* argued that Cold War anxieties about nuclear weapons fed largely irrational fears of nuclear power. Weart argued that these exaggerated portrayals in turn created distorted clichés of the risks posed by nuclear power. These distortions were communicated through visual images in movies and other sources of popular culture. [76] While this argument makes sense for what are referred to here as *supraconventional weapon effects*, it breaks down when applied to fallout. The term supraconventional refers to the effects of nuclear weapons, such as blast and fire, which are essentially similar to conventional weapon effects except for their geometrically larger scale. In contrast, fallout was an *extraconventional weapon effect*. Extraconventional weapon effects, in contrast to supraconventional effects, are primarily radiological effects and, secondarily, other medical effects, e.g. flash blindness, uniquely associated with nuclear weapons.[77] Given fallout itself was all but invisible and during the era of atmospheric testing effectively was an actual wartime effect taking place in peacetime, fear of it in the present was qualitatively different than a more generalized future fear of nuclear war. Moreover, evidence presented here will argue policy change was forced on the government, not solely by the subjective fears of the public, but in large part by the empirical effects of fallout, raising significant questions about the complexities of application of Weart's theory to fallout itself.

The prospect of atomic-scale destruction and the ambiguous nature of fallout was profitably mined for literary fodder in the postwar nuclear information vacuum and then sold to readers whose shared anxieties about nuclear war were nonetheless demonstrated by the popularity of postwar fiction liberally dosed with radiation. Fallout was mysterious, but hardly anonymous. In secret, fallout clearly distinguished nuclear weapons from conventional weapons,

[76] Weart, *Nuclear* Fear, Preface. For most purposes, the definition of supraconventional effects matches what the U.S. military historically termed "military effects," while it typically ignored the closely coupled issue of fallout and other radiation effects for strategic planning purposes throughout the 1950s.
[77] While the primary reference refers to fallout, the radioactive debris and gases lofted by a nuclear explosion into the atmosphere that then spread its threat over a wide area, extraconventional effects also include gamma rays and other prompt radiation effects that occur in close proximity to the explosion, as well as other non-radiation effects.

but over nearly a decade of a secret life that saw it used as a vital source of intelligence, the nature of that relationship and fallout's meaning remained publicly, intentionally ambiguous.

Ray Bradbury's dystopian 1953 novel, *Fahrenheit 451*, offered an example of how the ambiguity of fallout sharpened the drama of the narrative, even when the mechanism and scope of its risks remained obscure. Bradbury cagily played upon the evils of the nuclear age by invoking fear of the unknown, a reliable narrative hook for drama, letting the reader's imagination define what fit as fearsome, rather than attempting to depict any single image as universally horrifying. Bradbury's novel described a network of secret knowledge co-existing inside a state at war, echoing all-too familiar resistance to the Cold War's polarities of Communism and McCarthyism. In the novel, members of a mass, grassroots resistance movement held forbidden knowledge as complete texts in their memory. This circumvented the ongoing physical destruction of books as the state sought to monopolize all information for its own benefit; the novel's concept paralleled fallout's hidden, yet revelatory nature in relation to the weapons that produced it.

As the novel neared its end, Bradbury's protagonist, Montag, gazed on a city as it fell under attack by horrendous weapons.

> And the war began and ended in that instant…The first bomb struck…He blinked once. And in that instant, saw the city, instead of the bombs, in the air…Montag watched the great dust settle and the great silence move down upon their world.[78]

Before 1954, the Truman and Eisenhower administrations waxed optimistic about the potential for nuclear power. Just as most politicians did, artists like Bradbury imagined apocalyptic nuclear attacks, but depicted the resulting effects as quite similar to those of conventional weapons, only magnified in scale. In these Cold War novelizations, art paralleled the perceived reality of life.

Official reassurance that radiation from testing was a negligible effect of little consequence was part and parcel of larger cultural forces seeking to normalize nuclear weapons

---

[78] Ray Bradbury, *Fahrenheit 451* (New York: Random House/Del Rey, 1953), 158-161. The novel was an expansion on a 1950 short story by Bradbury, setting the original conception of dust in the story, largely centered on the biblical "dust to dust," more firmly in the "pre-fallout" era. The novel description of nuclear war was shaped by Bradbury's vision of an apocalyptic future just then coming into focus on the cusp of the era of an arms race based on weapons that were similar to, but many times more powerful than conventional ones, thus the formulation here of the term *supraconventional effects* in conceptually separating phenomena unique to nuclear weapons from those which are simply scalar extrapolations of the effects of conventional weapons, such as blast and fire.

and fallout, contributing to the cultural militarization of Cold War society and family life identified by Elaine Tyler May.

> One new requirement for the professional homemaker was expertise in dealing with the possibility of nuclear war…A major goal of these civil defense strategies was to…help fortify the home as a place of security amid the cold war.[79]

The combination of total war and nuclear weapons brought about two competing visions of American culture. The U.S. government promoted an ideological, pervasive, nuclear-armed unitarianism of its own to confront and contain the threat of global Communism, with NSC Directive 68 as its guiding philosophy.[80] Fallout as a problem threatened this vision of nuclear weapons as essential guarantors of national security. Because of the service's dominant role in shaping nuclear strategy, fear of fallout came to be seen by the Air Force as a competing, pervasively subversive force sapping the political energy required to resist Communism.[81] Tyler May's identification of its invasion of the home demonstrated its pervasiveness. The Air Force's assignment of ideological value to fallout demonstrated the fundamental depth of fallout's influence behind the scenes.

For the most part, indifference to fallout ruled. Prior to 1954's CASTLE BRAVO fallout incident with the *Lucky Dragon*, the few public reports about radioactive debris created by nuclear testing treated it as known and manageable effect of little importance.[82] Members of the U.S. military were taught fallout was a short-lived, inconsequential by-product of nuclear weapons. A wallet-size 1950 summary card of nuclear weapons effects reflected the United States military's official marginalization of fallout as a threat. The card provided assurance radiation from fallout produced by nuclear weapons was "So small it is not a hazard. Disregard it."

---

[79] Elaine Tyler May, *Homeward Bound: Americans Families in the Cold War Era* (New York: Basic Books, 1988), 90, 93; Laura McEnaney, *Civil Defense Begins at Home: Militarization Meets Everyday Life in the Fifties* (Princeton: Princeton University Press, 2000), 5-10; Michael Scheibach, *Atomic Narratives and American Youth: Coming of Age with the Atom, 1945-1955* (Jefferson, NC: McFarland & Co, 2003), 7-9, 15-49.

[80] A common observation among critical observers of warfare over the centuries is that combatants often take on aspects of the other. The post-Great Depression rehabilitation of capitalism was engendered in large part by World War Two, but only became a virtual civic religion as a counter to Communism once the Soviet Union became enemy, instead of ally.

[81] Quoted on page 29, General Thomas Power's secret 1959 appeal in favor of more fallout was one of the more extreme expressions deriding fear of fallout as a substantive factor in nuclear war from the service's leadership.

[82] P.D. Smith, *Doomsday Men: The Real Dr. Strangelove and the Dream of the Super Weapon* (New York, St. Martin's Press, 2007), 367. Smith attributes first use of the term "fallout" to Richard Gerstell, *How to Survive an Atomic Bomb* (Washington, DC: Combat Arms Press, 1950), citing the June 1995 edition of the *New Yorker*.

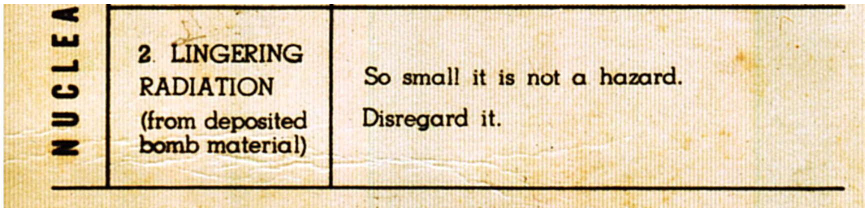

Figure 1: "Effects: Air Burst of Atomic Bomb"[83]

Fallout was hard to detect and unlikely to cause widespread harm in the limited quantities generated by testing relatively low yield fission weapons. This served to conceal its vital use for nuclear intelligence prior to 1954.

In the Beginning: Proving Basic LRD Techniques

The 1946 CROSSROADS test series provided the first opportunity for long range detection (LRD) of nuclear weapon effects. CROSSROADS initiated a continuing intimate association between nuclear test series and research and development in support of LRD, with the AEC's weapons program test shots serving as open air laboratories for many aspects of the military's research and development program in nuclear intelligence.

Sonic detection utilizing a Navy-developed system showed some promise at the TRINITY test shot in July 1945, but lacked the range needed to detect explosions within the USSR. The atmosphere channeled sound for remarkable distances, but required a detection system placed at a constant 45,000 foot altitude, a height only possible to sustain at that time through balloon-borne sensors.[84] Research on specialized constant altitude balloons made out of the new plastic, polyethylene, provided a vehicle useful for other high altitude atmospheric research purposes, even though the MOGUL program, provided inconclusive results.[85]

Aerial radiological sampling showed much greater promise at CROSSROADS. Drone aircraft were used to limit the unfathomed hazards to humans from radiation exposure, penetrating the cloud of the first shot, ABLE, followed by manned aircraft tracking the cloud out some 500 miles. Samples were collected during 357 sampling flights at longer ranges, and then forwarded by aircraft to an army office in Berkeley, California. Neither the aircrews nor the employees of the Standard Oil Company laboratory doing the sample analyses knew anything

[83] *Effects: Air Burst of Atomic Bomb, GTA 20-1* (Washington, DC: USGPO, 1950). Image taken from fission weapon effects card issued to U.S. troops. Author's collection.
[84] Zeigler and Jacobson, *Spying without Spies*, 41-4.
[85] Ibid, 55; 103-107. One unanticipated result of the MOGUL program was the discovery of debris from the balloon and payload of a failed test flight near Roswell, New Mexico in 1947, setting off rumors the crash involved aliens operating an unidentified flying object. http://en.wikipedia.org/wiki/Roswell_UFO_incident.

more about their source.[86] This policy of compartmentalization, a legacy of the Manhattan Project to preserve secrecy, continued as a constant feature of the LRD program.

Results from the second CROSSROADS shot, BAKER, suggested a different view of the utility of LRD. BAKER was an underwater shot and caused such intense contamination of the test site facilities and ship-borne support units that the third shot of the series was cancelled. Despite intense local fallout, BAKER saw little in the way of its fallout detected beyond the test site itself. Untested techniques had much to do with the relative elusiveness of the fallout cloud from BAKER. The mixed results pointed out how much was still to be discovered about fallout and LRD, leading to the conclusion radiological methods, while feasible, were probably only effective at ranges of 2,000 miles or less, and only if accurate weather data was available for the intervening area, clearly inadequate for detecting an explosion deep within the USSR. [87]

Bureaucratic and funding disputes about the feasibility of LRD research and development were protracted, centering on the prospects of different lines of research (radiological, seismic, and sonic) and the overall priority to be given in implementing the results to configure an operational LRD network.[88] This complex work was one example of projects the Research and Development Board (RDB) of the Joint Chiefs of Staff considered and reviewed. Because it controlled military scientific and research funding, the RDB became the battleground for the contending forces shaping the future direction of LRD. The successful discovery of the first Soviet nuclear test, Joe-1 (29 August 1949, 22 kilotons), in September 1949 removed the bulwarks to funding, but created hard feelings between the military and many scientists that persisted due to perceptions among the Air Force that some reviewers, most significantly J. Robert Oppenheimer, down-rated LRD proposals the service felt should have drawn support. Resistance to funding the needs of the new intelligence organization was largely due to the austere funding climate of the late 1940s. Nonetheless, proposed funding for LRD research and development amounted to nine percent of total military R&D spending in 1947, an indication of

[86] Zeigler and Jacobson, *Spying without Spies*, 48. This also suggests that the history of science applied to petrochemical analysis may offer insights into useful techniques for intelligence purposes incorporating radioisotope analysis.
[87] Ibid, 53.
[88] Ibid, 89. The Army and Navy felt that 1952 was the earliest date for a Soviet weapon, while the Air Force gave an estimate of 1949. The Air Force would consistently over-estimate Soviet capabilities throughout most of the Cold War, but this initial estimate proved surprisingly accurate.

the high priority attached to LRD from the beginning.[89] With LRD a still unproven concept, Defense Department reviewers remained cautious in investing its limited research resources.

Despite the reluctance of others, the newly independent Air Force retained faith in the concept. This work took place within the Special Weapons Group (SWG), a subordinate unit of the Air Force deputy chief of staff for material. The Air Force SWG represented Air Force interests associated with nuclear, or "special," weapons working in coordination with the Armed Forces Special Weapons Project (AFSWP), the military's coordinating unit with the AEC. The military services also organized the Joint Nuclear Energy Intelligence Committee (JNEIC), an oversight group that worked in coordination with the CIA's Nuclear Energy Branch.[90] While the other services had an important role to play, at its founding in 1947 the leading role among the military services in collecting and analyzing fallout, along with other forms of LRD, was assigned to the Air Force shortly before its independence, fitting with General LeMay's argument that aircraft could greatly facilitate detection that was approved through an order by General Dwight Eisenhower.[91]

The Air Force SWG established an office in its material branch called AFMSW-1 (an office symbol standing for "AF=**A**ir **F**orce, M= Deputy Chief of Staff for **M**aterial, SW=**S**pecial **W**eapons Group, Section **One**") on 14 December 1947 with the mission of conducting Air Force LRD research efforts at the upcoming SANDSTONE test series, as well as developing an interim LRD network.[92] SANDSTONE provided the AEC with "a laboratory with space"[93] to test new, more efficient weapons designs, while LRD R&D was added in order to calibrate instrumentation and techniques useful in development of a permanent LRD network.[94]

Code-named FITZWILLIAM, the AFMSW-1 program at SANDSTONE was organized by AFMSW-1's technical director, Dr. Ellis Johnson, a pioneer in the field of operations research. Johnson relied on two different sectors, supporting military units and outside contractors, which came to characterize how the relatively small LRD organization operated on a global scale. First, AFMSW-1 called on the Air Force's Air Weather Service (AWS) and the Army's Signal Corps, along with other government resources to fly aircraft and staff ground

[89] Zeigler and Jacobson, *Spying without Spies*, 151-170.
[90] Richelson, *Spying on the Bomb*, 73-74.
[91] United States Air Force Technical Applications Center, *A Fifty Year Commemorative History*, 3.
[92] Zeigler and Jacobson, *Spying without Spies*, 95; 118.
[93] Lookout Mountain Laboratory, *Operation SANDSTONE* (Hollywood: USAF Lookout Mountain Laboratory, 1948), movie.
[94] Zeigler and Jacobson, *Spying without Spies*, 86-7.

stations during FITZWILLIAM. To provide support for the necessary radiochemical analysis services, AFMSW-1 contracted with a private company, Tracerlab of Boston, Massachusetts, since AEC radiochemists were already fully committed to its weapons development program. [95]

While a highly classified military project, the Air Force relied on an extensive, diverse network of security-cleared contractors and research institutions to develop the AEDS in conjunction with military and DOD civilian personnel. Security clearances created a virtual community composed of those with the special access to hold them. However, participants in the small group also actively sought out new ideas and collaborations in the wider scientific community, although direct approaches were generally made only to those properly cleared to do the work. This tactic forsook much of the benefit scientific discourse could bring wider knowledge of particular problems to bear upon, but it avoided the issues of too-independent science that surrounded the first use of nuclear weapons on Japan.[96]

FITZWILLIAM's tasks were extensive. Nineteen different projects, ranging from further work with the partly-proven aerial radiological sampling technique to a rather speculative attempt to observe the flash of a nuclear explosion reflected from a dark region of the moon, were scheduled in an area that stretched from Tokyo on the west to Frankfurt, Germany in the east and from the latitude of Point Barrow, Alaska south to the latitude of the Panama Canal. Five weather reconnaissance squadrons flying WB-29 sampler planes (466 missions for a total of 4,944 flying hours over the course of FITZWILLIAM's three shots) were supplemented by a network of 67 ground stations, supported by four analytical laboratories run by Tracerlab.[97]

There were three objectives for the radiological sampling experiments. One was to determine how large a sample was needed in order to effectively analyze it. For the first time, gaseous samples were taken to supplement the debris caught on filters. Noble and other gaseous isotopes played a key role as nuclear intelligence sources. Second, techniques useful for tracking fallout plumes were developed, in order to maintain contact with them to capture better samples over long distances. The third objective was to determine if ground-based sampling could

---

[95] Zeigler and Jacobson, *Spying without Spies*, 118-123. Johnson solved the Navy's problem of consistently high rates of torpedo failures, then worked on programs increasing the effectiveness of air operations against Japan.
[96] Upon learning the operational use of the first nuclear weapons was imminent, a significant number of Manhattan Project scientists appealed to President Harry Truman to restrict its use to a purely military target or for demonstration purposes. They formed the core of what was known as the "scientists movement"
[97] Ibid, 128-129.

effectively substitute for more costly aerial sampling.[98] Even with the substantial priority the nuclear intelligence program held, researchers were already being pushed to effectively minimize the resources needed to accomplish the mission. The results of aerial sampling were considered superior to those taken by ground stations, and it became the primary sampling method used by the Air Force. Significantly, the use of relatively ineffective ground stations was considered adequate when later used as a method by the AEC and other civilian users for monitoring the spread of fallout. This differential in capabilities suggests this was not a result of funding shortages, but a purposeful restriction on the quality of the data available for fallout research.

Sonic, seismic, and a variety of other geophysical phenomena produced by a nuclear explosion were studied. Coordinating the vast variety of different observations was a global precision timing system. The timing of the tests, unlike at CROSSROADS, was not announced in advance, in order to deprive the Russians of an opportunity to make experimental observations similar to those AFMSW-1 planned at SANDSTONE. [99]

The possibility that each American test gave away secrets to the Russians took some time to sink in. Testing in the atmosphere inevitably compromised sensitive design information, as the tests' documentation by FITZWILLIAM revealed. Why, despite fallout's potential for an enormous security breach the Air Force and the AEC both were quickly cognizant of, was so little done prior to the 1963 LTBT to sharply limit testing fallout? In the short term, the answer was the Air Force likely knew the Russians could make no more than a token effort to recover samples or draw data from American tests in Nevada, in comparison to the fact American intelligence stations surrounded the Soviet Union to capture samples with relative ease. In the beginning, the secrecy of nuclear testing conveyed the illusion the tell-tale signs of a nuclear explosion could be hidden by simple discretion. FITZWILLIAM proved the fallacy of that belief, a secret that was of great initial significance, but which proved to have a short half-life.

Aerial sampling at SANDSTONE was of two different kinds, conducted under much higher security levels than at CROSSROADS.[100] Close-in sampling of the rising stem of the explosion cloud was done by B-17 drones, unmanned remote control aircraft that flew through the most dangerous portions of the cloud to collect samples in the immediate aftermath of the

[98] Zeigler and Jacobson, *Spying without Spies*, 127.
[99] Ibid, 131.
[100] Leland Taylor, *History of Air Force Atomic Cloud Sampling* (Kirtland AFB, New Mexico: Historical Division, Office of Information, Air Force Special Weapons Center, Air Force Systems Command, 1963), 15.

explosion.[101] This precaution was taken to avoid exposing pilots to the still mostly unknown effects of radiation, although four of the servicemen that collected the exposed filters from the aircraft after they landed received serious beta radiation burns due to a lack of proper procedures. Analysis provided a baseline composition of the radioactive isotopes generated in each explosion, because "radiochemistry furnished the key to finding bomb efficiency," a necessity for SANDSTONE's primary objective of proving new bomb designs.[102] This work had application to assessing the progress of the U.S. weapon development program, but it was also a key feature of developing radiochemistry useful for analysis of future samples from foreign tests.

An "Accidental" Breakthrough in Search of "The Right Stuff"?[103]

Longer range sampling of the downwind fallout plumes was done by Air Force Air Weather Service WB-29s. These lumbering converted bombers were fitted with specialized weather instrumentation; probes were installed in their noses and "bug-catcher" filter holders located on top or bottom of the fuselage identified radiation as present and collected the samples on filter paper. One of these aircraft was said to have "accidentally" penetrated "a finger" of the main cloud of SANDSTONE ZEBRA (the third and last shot of this series); the flight's command pilot, Lt. Colonel Paul Fackler noted, "no one keeled over dead and no one got sick." The incident served as an opportunity for Fackler to argue for the greater effectiveness of manned samplers over the primitive drone technology of the late nineteen-forties and early nineteen-fifties. In a dual role as radiation safety monitor aboard the aircraft, the aircraft commander allowed it to continue through the cloud for some forty minutes, which indicated a more determined effort to be in the wrong place than a simple oversight in flying through a cloud "finger." Based on the still-unproven radiation exposure standards of the day, the aircraft fuselage appeared to provide enough protection for the crew, leading to substantial abandonment of the unreliable drone aircraft in future test series in favor of more reliable piloted samplers for all but the most intense areas of radiation sampling within the plume. The results were greatly improved; the weakest sample at SANDSTONE proved much stronger than any taken at

[101] Lookout Mountain Laboratory, *Operation SANDSTONE*. Many isotopes of weapon design and intelligence interest possessed very short half-lives, placing a premium on rapid return of samples for analysis.
[102] Hacker , *Elements of Controversy,* 34, 29.
[103] "The Right Stuff" was a commonly used term among test pilots, notably memorialized in the 1979 Tom Wolfe book, and the 1983 movie whose screenplay was derived from it, on the dauntless cohort of jet test pilots who formed the core of the early astronaut corps for NASA. The known dangers of flight itself were overshadowed by the largely unknown dangers of radiation for those who flew sampler missions.

CROSSROADS. [104] The change traded greater efficiency versus increased human exposures.

While attributed to accidental discovery in the official history, later evidence strongly suggested the incident was staged by the Air Force in its eagerness to improve on the limited performance of the drone fleet and advance the state of the art in fallout sampling. At the heart of this story as the aircraft commander and safety monitor was University of Illinois graduate Paul Fackler. Born in Tolono, Illinois in 1915, Fackler took his B.S. degree in 1938. Fackler then enlisted in the Army Air Corps at Chanute Field in Rantoul, Illinois. An exceptional pilot, Fackler spent the bulk of World War Two training other pilots. In 1946, Fackler was assigned command of the air element at CROSSROADS, impressing his superiors enough they put him in command of the 55th Weather Reconnaissance Squadron (Very Long Range).[105] By 1948, Fackler commanded the 514th Weather Reconnaissance Squadron, tasked with establishing procedures for the air element of the interim network, the Air Weather Service, that became an essential supporting element in the Atomic Energy Detection System (AEDS) operated by AFOAT-1.

A colleague later recalled an alternate account from the official one that pictured Fackler as "inadvertently" entering the cloud, dismissing the official narrative as not in accord with his understanding of Fackler's skills as an aviator.

> Upon landing, Fackler discussed the penetration with Col. Cody, the assistant Rad-Safe Officer for Operation SANDSTONE. It is obvious that Fackler thought that manned cloud penetrations were possible, perhaps even desirable. I wonder just how inadvertent this penetration was. From all accounts, Paul Fackler was a very good B-29 pilot. I have not heard of too many inadvertent things happening while he was at the controls. Let's just say that he may have been pushing the envelope a bit.[106]

The circumstances strongly suggested Fackler fabricated a ploy designed to create a positive record to justify sending the Air Weather Service's and other samplers into radioactive plumes,

---

[104] Taylor, *History of Air Force Atomic Cloud Sampling*, 20-23 Another officer attached film badges to the outside of some of the drone aircraft and inside in the flight positions the crew would otherwise occupy if it had not been under remote control. Comparisons of the relative exposures suggested piloted samplers could approach the cloud more closely, but this took place simultaneously with Fackler's "accidental" three-quarter hour cloud penetration so did not provide a prior understanding to support Fackler's action.

[105] In October 1946, Fackler was command pilot on a sortie that painted the first radar image of a hurricane in the Gulf of Mexico, pioneering a mission still flown today.

[106] Air Weather Reconnaissance Association, "Col. Paul H. Fackler, 1915-1986," February 2007, http://www.awra.us/gallery-feb07.html.

an idea reinforced when Fackler later appeared commanding samplers at a later test in a film designed to reassure aircrews about the safety of the task at hand.[107]

Most of the other experimental techniques, including a moon-bounce experiment (hoping to see the flash of a nuclear explosion on earth reflected from the moon) and the MOGUL balloon-borne sonic detection system, gave disappointing results. Ground-based sonic techniques showed promise, but still lacked adequate range (with detection out to 1,700 miles) to detect an explosion deep within the USSR. Despite all of SANDSTONE's shots taking place on towers to limit the amount of local fallout, seismic techniques provided surprisingly effective detection out to 500 miles. The big success was the improvement in aerial radiological sampling, with airborne Geiger detectors tracking the debris cloud while giving up to a thousand times more sensitivity than from the ground, proving the value of aerial sampling aircraft in tracking the drifting plumes of fallout. An aerial sample gathered near Tripoli, Libya, 12,000 miles away, proved sufficient for effective analysis.[108] The results encouraged the Air Force to focus its research and development funding on aerial sampling and seismic techniques. The tests clearly demonstrated the ineffectiveness of a wholly ground-based detection system, which was destined to sharply limit successful sample collection for access to data required for civilian research in this area.

Oppenheimer and Long Range Detection: From Fallout Skeptic to Believer

Beyond proving long range detection was a workable idea, another concern with the reliability of radiological sampling was also resolved by FITZWILLIAM. J. Robert Oppenheimer theorized a high-altitude explosion might be used by the Russians to evade detection, since there would be no ground debris to be sucked up and transmuted into fallout, with the bomb itself vaporized in the fission reaction. Dr. Frederick Henriques of Tracerlab noted Oppenheimer's concern and made calculations that indicated the agglomeration of the gaseous materials in the debris cloud as they cooled would nonetheless produce detectable debris. Samples from FITZWILLIAM were observed with just such microscopic shiny, spherical bomb debris. From this, Dr. Johnson concluded in a report sent to the AEC that AFMSW-1 would likely be able to detect an atmospheric explosion by the Soviets, no matter what the burst

[107] *Military Participation on BUSTER-JANGLE*, (Hollywood: Lookout Mountain Laboratory, U.S. Air Force, 1:17:00 film, 1952. Fackler appeared as the commander of the sampler crews in this documentary report on air operations. One scene shows the crew being advised at the preflight inspection by the command pilot, "You've all been briefed on the amount of radiation you can get and still be on the safe side. I'd like to assure you will never get enough radiation on the inside of this aircraft to give a thought to the consequences."
[108] Zeigler and Jacobson, *Spying without Spies*, 133-4.

height.[109] This proof of concept showed the only thing standing in the way of a radiological debris detection capability from sea level to space was a vehicle capable of carrying the sampler filters, as it was impossible to conceal such an explosion.

Despite concern about Soviet efforts to conceal test shots by firing them at high altitude or in a rainstorm (to cause a "rain-out" effect, similar to what happened unintentionally at the CROSSROADS BAKER shot, limiting the spread of fallout away from ground zero), the consensus of the U.S. intelligence community was the Russians were likely to use a tower shot for initial testing, just as the United States did at TRINITY, in order to minimize local fallout while maximizing opportunities for experimental observation. Observations of FITZWILLIAM's three shots proved the viability of airborne sampling to detect radioactive debris from a nuclear explosion, while suggesting other supplementary techniques were viable, but needed more work.

One important result was to clarify the future role of xenon-133 monitoring, which could determine whether the Soviets were producing fissile material. Prototype cryogenic collection systems flew on samplers at all three shots of SANDSTONE.[110] First used to monitor German nuclear efforts at the beginning of the U.S. nuclear intelligence program during the Manhattan Project, xenon-133 was initially known to be emitted by operating plutonium production reactors. Later, it was determined explosions of nuclear weapons also created xenon-133. Moreover, Ziegler and Jacobson indicated an "unknown adsorption process" was scavenging xenon-133 from the atmosphere. This made it an unreliable source for monitoring Soviet fissile material production, shifting interest to krypton-85 as a result of sampling at SANDSTONE.[111]

The following explanation for the change to sampling krypton-85 appears to account for this "unknown adsorption process." A noble gas generally chemically unreactive with other elements, xenon-133 has a total half-life of just over seven days, but its decay transformed it into stable cesium-133, changing the composition of the samples taken into an element, cesium, which is chemically active in the atmosphere, unlike xenon or krypton, also a noble gas.[112]

---

[109] Zeigler and Jacobson, *Spying without Spies*, 136-8

[110] Ibid, 182-3. Xenon-133 has a bifurcated half-life, a little over two days, followed by an isometric transformation to standard Xe-133 with a ~5.25 day half-life followed by a beta emission decay to cesium-133.

[111] Both xenon-133 and krypton-85 are produced in direct proportion to the production of plutonium in reactors.

[112] H.L. Finston, and M.T. Kinsley, *The Radiochemistry of Cesium* (NAS-NS-3035) (Upton, NY: National Academy of Sciences: National Research Council, 1961), 6. "Cesium [in its pure metallic state] is the most active and the most electro-positive [i.e. low ionization] of all metals, and on exposure to air it tarnishes quickly and melts due to the formation of impurities or bursts into flame." Thus any stable cesium-133 created by the decay of xenon-133 would immediately react with air to form such compounds as cesium oxide.

Cesium produced by the decay of xenon-133 quickly reacts with air, accounting for the scavenging effect which removed xenon-133 from the atmosphere. Likewise, while the half-life of xenon-133, followed by rapid analysis of the samples taken, was adequate for aerial sampling against Germany, the geographical extent of the Soviet Union meant potential xenon-133 samples would already have largely decayed into chemically reactive, but non-radioactive, cesium before they reached areas where they might be sampled and analyzed.

Krypton-85, on the other hand, has a half-life of 9.4 years; samples were subject to minimal decay that might affect analytical use of this radioactive, yet chemically inert gas and, thus, affect the accuracy of the estimate of the rate of Soviet plutonium production. Additionally, the longer half-life of krypton-85 made possible continuous monitoring of its concentration in the atmosphere to refine previous estimates of plutonium production, making these estimates more accurate the longer the krypton-85 monitoring continued. Because these technical reasons made its measurement less difficult and more productive than xenon-133, krypton-85 became the primary isotope of interest to AFMSW-1 in estimating Soviet plutonium production rates. By early 1949, it was quite likely the first efforts in the USSR to produce plutonium-239 were detected by the United States, leading to a heightened sense of alert by the Air Force's Interim Surveillance Research Net, eventually rewarding the effort with detection of Joe-1.

Another significant result from FITZWILLIAM was somewhat speculative, but appeared to have occurred based on information available from sources other than Ziegler and Jacobson. They assert efforts to measure ionospheric effects were cancelled due to interference between the experimental ionospherograph at the test site and the control channels for the drone planes used for sample collection.[113] However, the Army Signal Corps operated a worldwide network of ionospherographs by this time, mainly for the purpose of predicting the best frequencies for shortwave radio circuits, but also for research purposes.[114] The Army Signal Corps was also a part of the Interim Surveillance Research Net.[115] The Signal Corps operated the sonic detection system (from 1948 to 1969) for AFMSW-1 (and its successors, AFOAT-1 and AFTAC) with this system being co-located at many Signal Corps listening stations with ionospherographs. Although the first claimed use of radio frequency techniques for nuclear intelligence was in 1953, it was possible that operators of the two adjacent Signal Corps systems at one or more of

[113] Zeigler and Jacobson, *Spying without Spies*, 133.
[114] Per a discussion with John Antony Wedge, UIUC doctoral candidate in history.
[115] Zeigler and Jacobson, *Spying without Spies*, 175.

these sites noticed a correlation between data each received during the FITZWILLIAM experiments and brought it to the attention of AFMSW-1.[116]

The deteriorating international political situation in 1948 (including the Berlin Blockade and the Czechoslovakia crisis) increased the pressure on decision makers to deploy an interim system based on airborne sampling techniques. AFMSW-1 was meant to be a development organization, with a plan that called for a two-year research program. Combined with the deteriorating international situation, the successes of FITZWILLIAM resulted in reevaluation of the original plans. A stopgap airborne sampling network was put into operation immediately, while research went forward on supplementary methods (acoustic, seismographic, etc.)

At the same time, the secrecy of the military's nuclear intelligence efforts, reinforced by a decision by the Joint Chiefs of Staff to accelerate the date for a complete operational system from 1951 to 1950, grew increasingly opaque to the AEC. Lewis Strauss, first a commissioner, later chair of the AEC under Dwight Eisenhower's administration, was often credited with being the father of LRD in the limited extant references in historical literature on the topic, primarily because of a series of nagging memos he wrote on the subject. Ziegler and Jacobson made clear his concerns about military foot-dragging had far more to do with the military keeping Strauss, along with the rest of the AEC, in the dark about the actual status of LRD system development efforts for security reasons, rather than any lack of effort.[117] Strauss, an investment banker who served in the Naval Reserve as an intelligence officer, had been an advocate of LRD since his appointment as an AEC commissioner. The series of increasingly questioning memos (which took the form of nagging letters to Dr. Ellis Johnson of AFMSW-1) addressed what he considered military dalliance in setting up a LRD system.[118] The reality was the military was already constructing a wall of secrecy around its nuclear intelligence efforts, one which intentionally isolated the AEC from anything other than limited, need-to-know knowledge about the military's fallout collection efforts. This established a mostly one-way flow of information

[116] AFTAC, *A Fifty Year Commemorative History*, 117. The 1953 official start date for use of EMP does not preclude it coming to notice experimentally prior to that time.

[117] Among those reasons for secrecy was that Robert Oppenheimer remained chair of the AEC's GAC after irritating the Air Force by his alleged lack of support for development of thermonuclear weapons, a topic to be discussed in more detail in Chapter 2. However, a countervailing view was that given the "need-to-know" nature of LRD, those like Strauss who did not possess that qualification likewise were not cognizant of Oppenheimer's prior relationship with LRD.

[118] Zeigler and Jacobson, *Spying without Spies*, 140-1.

from the AEC to the military as it began construction of the Atomic Energy Detection System (AEDS).

Brigadier General Don Yates of the Air Weather Service saw LRD as an opportunity to bolster the case for funding his command's mission of weather reconnaissance. In the era before satellites, weather observation and prediction in remote areas and over the oceans was produced by synoptic observations, in which aircraft flew daily missions on a fixed track, gathering data from the same approximate location at the same time to produce daily data for forecasting. With some of the AWS's WB-29s (weather reconnaissance variants of the B-29) equipped with sampling equipment from testing, Gen. Yates felt the AWS's ongoing work provided ideal cover for LRD to operate, along with providing essential support for the daily flights needed to assure the kind of coverage necessary so that evidence of a nuclear explosion would not be missed. Yates hoped the high priority attached to nuclear intelligence meant its funding could provide a stable source of support for other AWS missions, which were accomplished by observations made by flying the synoptic tracks in search of nuclear debris.[119] Yates volunteered the AWS as ready to accept the LRD mission, but little else is known about the decision which initiated WHITESNAKE, as the AWS portion of the overall LRD surveillance program was originally known, since most of these discussions were in "verbal form [only,] for security reasons."[120] Even where relevant documents are available in declassified form, the spotty evidence available is representative of the need for historians to evaluate and inferentially render accounts based on commonsense interpretations of the historical record. The results, if not all the reasoning, were obvious: the mundane repetition of the synoptic missions of the AWS provided an ideal cover for LRD operations while the nuclear intelligence mission underwrote a substantial part of routine AWS operations. New intelligence requirements generated the need to hastily initiate operations given the high priority of nuclear intelligence. The Air Force has a rich tradition of such improvisational efforts for work of lower priority than LRD, with the Interim Network another example of how such ad hoc efforts were frequently relied upon by the Air Force.

While the Air Force moved forward in great secrecy building its interim LRD network, approval for funding the extensive research plan initiated by Dr. Johnson languished in the bureaucracy. The National Security Act of 1947 established the Research and Development

---

[119] John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), 246. ©American Meteorological Society. Used with permission.
[120] Zeigler and Jacobson, *Spying without Spies*, 143.

Board (RDB) to manage and prioritize military research and development programs to avoid duplication and waste, but overall R&D languished in the austere postwar funding climate. At the same time Dr. Johnson's staff was carrying out the experimental work connected to FITZWILLIAM, he also was planning the operational LRD network. After several rejections by the RDB, Dr. Johnson became frustrated to the point he resigned in protest over the onerous process of approval.[121] Dr. George Shortley briefly succeeded Johnson as technical director of AFMSW-1 and updated the proposal to included expanded emphasis on seismographic research in the wake of the FITZWILLIAM project results, along with further research to determine overall Soviet nuclear material production via analysis of noble gas (krypton-85) samples. Since the most obvious way for the Soviets to avoid detection by radiological air sampling was to test underground, seismic detection became a constant Air Force anxiety despite a record that showed virtually no evidence of such efforts for another decade. However, the Air Force felt seismic detection should be a high priority in order to have a comprehensive and redundant monitoring system.[122] The AFOAT-1 unit history, written in retrospect and not published until June 1954, cast the requests for more documentation to justify the research needs by the Pentagon's RDB as hostile interlopers.

> Consequently all those who for any reason – lack of confidence in the feasibility and value of an LRD system, [line of text redacted] or a genuine desire to put the government on a policy of economy – desired to hinder the AFOAT-1 program could do so by pointing out that only limited funds should be invested in a questionable venture and one which had no high priority attached to it.

Seismic research thus received the bulk of research and development funding under the proposal in the hope seismography could soon complement the now proven air-sampling technique. The frustrations of Dr. Johnson were representative of the increasingly conflictual relationship between the military and science. However, it was the eventual success of this nuclear intelligence program that played a part in reviving the Pentagon's faith in working closely with

---

[121] Given Oppenheimer's key role on the RDB, this rejection of the work by one of their own was another likely point of memorable conflict between AFOAT-1 and Oppenheimer.

[122] Zeigler and Jacobson, *Spying without Spies*, 146-148; AFOAT-1, *History of Long Range Detection, 1947-1953* (Washington, DC: AFOAT-1), 13. Despite the plain and urgent language of General Eisenhower's order that the Air Force develop and operate a LRD system, the Joint Chiefs of Staff inexplicably assigned no priority to the project, a death knell for any large defense program and a major factor cited in the RDB's reluctance to fully fund the Air Force request. Similar seemingly embittered language toward the RDB crops up periodically, suggesting an ex post facto recasting of the same bitterness expressed by witnesses toward Robert Oppenheimer at the 1954 hearing.

science – on the military's terms – after the political fallout caused by the dissension of the Manhattan Project's scientists over nuclear weapons policy faded.

While the seismic research proposal worked its way through the Pentagon's bureaucracy, the Air Force moved ahead in anticipation of eventual approval of the LRD program by moving AFMSW-1 resources to operational status and redesignating the organization AFOAT-1 (like AFMSW-1, an office symbol representing "***A***ir ***F***orce, Deputy Chief of Staff for ***O***perations, ***At***omic Energy Office, Section ***One***") on 28 August 1948.[123] AFOAT-1 began operating the Interim Surveillance Research Net in the wake of FITZWILLIAM, integrating most of the equipment and ground stations participated in experimental operations into the interim operational network at minimum cost.[124]

Meanwhile, the RDB was far from finished in its review of the LRD research proposal. As the Air Force pushed ahead with the LRD R&D program and interim network, it scrambled to cover ongoing costs by creative accounting while the program awaited formal approval. Two different panels (the Loomis Panel, named after its chair, Alfred L. Loomis, and the Boner, or IO-7, Panel, named after one of its members who had previously served on the Loomis Panel) reviewed the LRD research and development proposal. Both panels complained about a lack of guidance from the DOD on the priority that should be attached to the project, the scope of the research (since air-sampling was proven, the need for other techniques was questioned), and pressures from Harry Truman's White House to reduce spending on research and development which lacked a proven need. The Boner Panel recommended the government use conventional intelligence methods, such as human agents, even though the USSR had already proven resistant to such tactics because of the insular, tyrannical nature of Stalin's regime. Importantly, the panel supported the use of technical means (krypton-85 monitoring) to detect fissile material production, but discouraged continued research investment in LRD of nuclear explosions.[125]

Doyle Northrup, AFOAT-1's new civilian technical director, fought for full funding of the Air Force's proposal, which included seismic and sonic research to complement and corroborate airborne sampling. While the Joint Chiefs of Staff (JCS) endorsed the main proposal for an interim surveillance network, they undercut the Air Force's proposal for seismic and sonic

[123] Zeigler and Jacobson, *Spying without Spies*, 150. The AWS's participation collecting aerial samples as the main operational element of the program was then redesignated from WHITESNAKE to WORKBAG.
[124] Ibid, 175.
[125] Ibid, 153-163.

research by downgrading the need for proof of the location of any putative Russian explosion to the rather more simple task of merely locating it within the Soviet sphere of influence if it should occur, rather than requiring a highly accurate fix on the test location. It was possible that the JCS were influenced by the Army, who may have felt the capability it provided to the Interim Net with its sonic detection system (and, possibly, its ionospherograph network) was an adequate supplement to airborne sampling, although it provided only a limited capability to give accurate direction-finding information. The proposal languished in review under the Truman administration's austere funding regime well into the summer of 1949. The Boner Panel finally issued its report on the LRD proposal on 1 September 1949, calling for a reduction in the scope of the Air Force's research program to concentrate LRD on the proven technique of airborne radiological sampling. On 14 September, the DOD's Management Committee issued a stop-order to limit expenditures by the Air Force to what they felt the RDB would approve based on the restrictive Boner Panel report.[126] Stunning news soon broke, making the proposed reductions in LRD funding moot. The quick discrediting of the Boner Panel's recommendations at the end of a long frustrating review process reinforced the Air Force's desire, also driven by Cold War security anxieties, to work only with scientists who clearly supported its programs, while screening out those it perceived as questioning its goals.

Joe-1: Verification of LRD Capability

Accounts vary of the 375th Weather Reconnaissance Squadron's RB-29 flight on 3 September 1949, which detected the first Soviet nuclear shot (known within the Air Force as Joe-1, in reference to Stalin.) The official history of AFTAC refers to it as "a routine, 13.5 hour, 'reverse LOON CHARLIE' mission," a conclusion echoed by several other accounts relying on this official source, including Ziegler and Jacobson.[127] Other sources tell a more nuanced story indicating AFOAT-1's Data Analysis Center (DAC) was ordering "special" missions based on

---

[126] Zeigler and Jacobson, *Spying without Spies*, 164-170.

[127] Ibid, 203-4. Zeigler and Jacobson indicated that the crew experienced numerous technical and weather problems getting airborne, yet persevered in continuing the mission. William B. Scott, a former AFTAC Special Equipment Operator (SEO) himself, repeated the official AFTAC account word for word in "Sampling Missions Unveiled Nuclear Weapons Secrets," *Aviation Week & Space Technology*, 3 Nov. 1997, 54-7; John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), 246-247. ©American Meteorological Society. Used with permission. Fuller also stated the mission was "routine." "LOON CHARLIE" was the specific synoptic track's code name the plane was assigned to fly between Japan and Alaska.

other intelligence indications.[128] Charles C. Bates and John F. Fuller vaguely refer to some of these missions being "vectored," or directed, to fly at specific times and on specific tracks other than those typically used.[129] These conflicting versions of AFOAT-1's best documented operational success strongly suggest the historical significance of this event was more complicated than previously reported. The series of alerts shortly before the discovery of Joe-1 suggested it was more than simply a lucky day on a routine mission, as accounts in AFTAC's commemorative history portray. Institutional perspective also played a role, as the official narrative was strongly influenced by the belief that fallout sampling was the paramount, irrefutable method of monitoring, with other sources of intelligence serving in a secondary role.

Jeffrey Richelson recounted CIA and British intelligence agents interviewed refugees and scientists fleeing Eastern Europe after World War Two, who provided considerable evidence the Russians were engaged in efforts to obtain and refine uranium, especially from known, very rich deposits located in Czechoslovakia. Along with these human sources, Richelson observed the United States collected considerable communications intelligence on nuclear topics before September 1949, but available declassified documents seem to indicate communications intelligence provided no specific smoking gun.[130]

Robert A. Mann, apparently working from 375th and Alaskan Air Command monthly unit histories, related a more nuanced account indicating AFOAT-1 had prior knowledge a Soviet test

[128] "Special" is a generic term used to refer to many things nuclear by the U.S. military. In the case of nuclear reconnaissance, we have already seen its use in the term SEO introduced in the last footnote (re Scott). In this context, "specials" refer to sampling missions ordered to be flown in addition to regular tracks, i.e. a special is a mission specifically ordered by what was euphemistically termed "higher headquarters," i.e. AFOAT-1 or the JCS, usually on the basis of some specific intelligence indicating that data can be obtained.

[129] Charles C. Bates and John F. Fuller, *America's Weather Warriors, 1814-1985* (College Station: Texas A&M Press, 1986), 137.

[130] Richelson, *Spying on the Bomb*, 75-77. Camp King, Germany, a location that rather ineffectively hosted an AFOAT-1 seismic detachment before it was removed to Spain, was an interrogation facility that provided opportunities to interview persons of interests who were recent refugees from the East. AFOAT-1 presence there prior to the seismic unit is unconfirmed, but strongly suggested given Camp King was one of the primary facilities that hosted such interrogations. Remarks on the effectiveness of WRINGER, the U.S. program to interrogate returning refugees indicated it was "our most remunerative air intelligence program…" a statement at odds with the findings of this paper about AFOAT-1's accomplishments. Reference was made to locating specific locations of Soviet nuclear installations in order to add them to SAC's target list. These remarks were included among an overview of U.S. air intelligence at the 1950 Ramey AFB commanders conference, http://www.gwu.edu/~nsarchiv/nukevault/special/doc03a.pdf, 12; and www.usarmygermany.com/Units/Military Intelligence/USAREUR_EUCOM Intelligence Center.htm. There was a documented presence of Air Force personnel at Camp King, but this is not definitive in locating AFOAT-1 there prior to the seismic unit's arrival, because the camp was a joint services facility. See: http://www.usarmygermany.com/Units/Military%20Intelligence/Partials_ECIC%207.htm. Goodman, *Spying on the Nuclear Bear*, 150-154, also discussed joint Anglo-American efforts to interrogate returning refugees in Germany, while omitting specific mention of Camp King.

was imminent.[131] On 19 August 1949, the 375th was ordered to fly a LOON SPECIAL mission, looping down to the end of the Aleutian Islands and back to Eielson, instead of continuing on to Japan, ten days before the 29 August explosion of JOE-1.[132] Based on average wind velocities, Mann estimated an alert on this date indicated a belief a Soviet explosion occurred as early as 13 August, five days before the alert was ordered on 18 August. Although the alert indicated daily flights were to be made, apparently negative results from this initial LOON SPECIAL mission led to the following missions being cancelled. Even with the cancellations, another interesting report was made by Alaskan Air Command:

> In response to a request by HQ USAF, a report was submitted concerning unusual radar, barometric, light, sound, and earth shock incidents observed through the period 21-22 August. Although only conjecture, it was believed that this was to amplify reports of the explosion of an atomic bomb by the Russians.[133]

Mann made a significant observation by pointing out the conflict between the 375th's original alert, which implied a relatively early date and distant location for the first Soviet shot, and the later more general alert for the entire Alaskan Air Command, which implied that any such shot would be obvious from "physical natures [which] would allow manifestations to reach Alaska in a period of time ranging from instantaneous (light) to hours (sound) after the explosion."[134]

Ziegler and Jacobson asserted flatly sonic detection did not "alert" AFOAT-1, but it was unclear how they formed this conclusion. Apparently, data from the sonic stations (only two of which were within 1,800 miles from the Soviet test, the range which these detectors were known to provide at this time) did show an anomaly confirming the explosion when examined after the fact. [135] Apparently, sonic data was not responsible for the alerts issued in Alaska.

Likewise, since the first alert indicated a need to be on the lookout for immediate phenomena from a possible Russian blast, it suggested an indication by the ionospheric network was possibly the source of an erroneous alert. Obviously, accurate data for an immediate alert could not have been provided prior to the actual date of Joe-1's detonation, 29 August. Likewise,

---

[131] Robert A. Mann, "Detection of the First Russian Nuclear Explosion," http://home.att.net/%7Esallyann4/bob-mann-column.html .

[132] LOON SPECIAL was one among the various standardized and code-named synoptic tracks the AWS crews flew. In later usage, inclusion of SPECIAL in the title indicated it was a flight vectored against a specific, identified plume; whether that was the case here was uncertain from Mann's usage.

[133] Quoted by Mann from the Alaskan Air Command history for 1949. He indicated that it is from page 50, most likely from the August history in the monthly format in which such USAF reports weere typically written.

[134] Mann, "Detection of the First Russian Nuclear Explosion."

[135] Zeigler and Jacobson, *Spying without Spies*, 189.

the skeletal, incomplete, and uncalibrated seismic system that was a part of the interim LRD network could only have yielded accurate data in a retrospective examination of information collected. Among the many secrets of LRD, the instantaneous detection capability of ionospheric detection (EMP) was especially sensitive and possibly the source of detected suspicious signals.[136]

The alerts were likely not based on 'just guessing.' There were at least three more possibilities to account for this series of alerts in Alaska before the first reported indication of Joe-1 was discovered. The first was information gleaned from communications intelligence, the monitoring of traffic on shortwave and other radio frequencies. Although the National Security Agency was not yet in existence, the military services maintained their own signals intelligence units after World War Two (which would eventually come under direction by the NSA after its formation in 1952.) It was possible the Soviets were indiscreet about the upcoming test or communicated about it on a circuit they believed was immune from monitoring. Such a slip up was at odds with the extraordinary secrecy associated with the Soviet nuclear project.

Another possibility was that some still unsung human source could have tipped off the United States to an imminent test. The United States was seemingly less successful in recruiting high-profile human sources than the Soviet Union during the Cold War, but it was also quite possible that the CIA may still be concealing the identity of a successful agent who pulled off such an intelligence coup. Failed spies often become infamous, but the best ones do their work undetected and unsung. Finally, krypton-85 monitoring may have been adequate to determine the Russians had created enough plutoniun-239 to indicate they were prepared to test in the near-term. In any case, this historical puzzle remains one deserving future attention in the broader field of Cold War intelligence history, as its low profile and suggestive problematization of seemingly settled fact point out an area in which more complete information from the classified archives is necessary to resolve it.

The first Soviet nuclear explosion occurred the same day, 29 August, as Crew 5A's initial attempt at flying the reverse LOON CHARLIE track back to Alaska, but was cut short by engine failure after leaving Yokota AFB, forcing an emergency landing at Misawa AFB in northern Japan. After repairs on 3 September 1949, First Lieutenant Robert C. Johnson and Crew 5A took

[136] EMP was later proven effective in detecting at least some underground blasts, thus making it reasonably effective against clandestine underground testing.

off from Misawa, overcoming these problems as the mission launched successfully in route to Alaska. Unknown it at the time, four and a half hours after take-off, the filters in the "bug-catcher" on their WB-29 began encountering debris that were later determined to originate from Joe-1. The weather officer of Crew 5A continued changing filters out of the "bug-catcher" every three hours on the flight. On arrival at Eielson AFB, the filters were handed over to the crew debriefing officer who passed them onto the AFOAT-1 representative, who took them to a secure facility only accessible to its personnel.[137] This separation between the AWS collectors and the AFOAT-1 analysts preserved compartmentalization, an important aspect of controlling the spread and use of information about nuclear intelligence within the Air Force itself.

At the restricted AFOAT-1 compound, the filters were placed into a new device called a wrap-around counter, installed just a month before. The wrap-around counter surrounded the samples with a one foot thick lead shield to screen out cosmic and background radiation, allowing its Geiger counter to produce more accurate radiation counts from the sample filter. The standard for an alert to be issued based on observed readings was reduced from 100 counts to 50 counts per minute when the wrap-around counter was first installed. The second filter exposed on the flight registered 85 counts per minute. This news was passed to the DAC in Washington, which logged it as Alert 112 (an alert first codenamed VERMONT by AFOAT-1 once a "hot" sample was confirmed.) After encountering a number of previous false alerts, due to such causes as volcanic activity or natural variations in radioactivity, this time was different.[138]

[137] Zeigler and Jacobson, *Spying without Spies*, 204; 1009th Special Weapons Squadron, Letter 55-3, 5 January 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6, College Park, Maryland. *Compartmentalization* was a key feature of AFOAT-1 operations. During this era, even within the unit, those assigned to different detection techniques collocated together at these already tiny remote detachments were technically supposed to not be cognizant of each other's work. This was impractical in practice and the orders governing this aspect of internal security were modified. A full discussion of the specifics and citations to the relevant documents of security culture in the unit follows later in this chapter. For those outside the unit, such as the AWS aircrews collecting the samples, there was even less knowledge. While the nature of the work, measuring radiation, was clear from the form itself, there was little to go on in terms of who received the data and filter papers from the sampler. The form included as an example in Letter 55-3 was indicated as being "SWS #20" but the meaning of the initials (Special Weapons Squadron) was arcane to those not assigned to the unit. There would be no reference at the forward location to the 1009th SWS (see discussion later in this chapter). The form itself was classified as SECRET, with the authority being the Air Force Chief of Staff, which concealed the actual directing authority for such operations, the Joint Chiefs of Staff. The form was constructed around the need-to-know principle, as was what happened next to the filter papers it accompanied once the aircrew passed both onward at the flight debriefing. The AWS aircrew had no need to know anything about the radiation counting operations of the AFOAT-1 and such knowledge would be a clear violation of orders governing such operations.
[138] AFTAC, *A Fifty Year Commemorative History*, 20-23.

At AFOAT-1 headquarters, the DAC ordered several actions to verify the sample. First, it was regularly re-measured. Plotting the continuing activity of these interval readings formed a recognizable radiation decay curve, indicating the sample likely contained bomb debris. Part of the sample was dispatched by aircraft (swift transportation was necessary so that the lab could quickly ascertain the rapidly changing mix of isotopes in the captured debris as they underwent decay) for analysis at the Tracerlab facility in Berkeley, California. With the rough location of the debris plume established by the first "hot" sample, more "specials" were ordered into the air on tracks stretching from Hawaii to Alaska to obtain further samples. One sample returned a count of over 1,000 decays per minute, well above the AFOAT-1 alert level, adding weight to the belief the sample was bomb debris. By plotting the decay curves of the various isotopes of barium, cerium, iodine, molybdenum, neptunium, ruthenium, silver, yttrium, and zirconium in the sample, laboratory analysis of the samples revealed their isotopes shared a "birth" date, confirming their origin in a nuclear explosion, rather than in a reactor accident.[139]

Nearly 100 "specials" were eventually launched in response to the initial alert, capturing more than 500 samples. The drift of the debris was tracked around the world, resulting in a hurried decision to notify the British to gain as complete a picture as possible of this first Russian blast. Technically a violation of the Atomic Energy Act's restrictions on sharing nuclear information with other nations, it was a choice of obeying the law or losing part of the most vital intelligence data of the postwar era.[140] Legal restrictions imposed by Congress might handicap AFOAT-1's mission, but were discreetly put aside by the military in the interest of expediency.

By 20 September, AFOAT-1 issued Technical Memo No. 37 attached with another memo from Air Force Chief of Staff General Hoyt Vandenberg concurring with its conclusion the samples showed consistent data pointing to the explosion of a nuclear weapon "over the Asiatic land mass during the period 26 August 1949 to 29 August 1949." This information was

---

[139] Zeigler and Jacobson, *Spying without Spies*, 204-205. Ziegler and Jacobson provide the details of the detection of Joe-1 not otherwise attributed to other sources in this passage. While many radiochemistry reactions overlap between those found in fission explosions and the slower, controlled reactions in a reactor, except at startup the reactor's mix of isotopes will have different birth dates because of the continuing nature of the reactor process versus the instantaneous creation of isotopes in a critical mass reaction. Thus, isotopes found in a reactor explosion's "hot" sample will show a wide range of decay half-lives, while those found in a fallout sample will track back to one specific time and date.

[140] Ibid, 203-7. This project outlines the subject of isotopic analysis and how it reveals information on weapon construction and efficiency in Appendix A. More information about the issue of overcoming legal difficulties to coordinate with the British, Canadians, and Australians, see Hewlett and Duncan, 261-314, for the background up through 1949.

forwarded by Secretary of Defense Louis A. Johnson to President Truman, a formal notification as follow-up, as the president had been verbally briefed on developments since the first indication it was fallout. Advisers urged him to make a public announcement, but Truman held off, hoping the Russians would announce it themselves, thus preserving secrecy about U.S. nuclear intelligence efforts.[141] As time passed without any announcement from the USSR, Truman concluded the Russians were apparently hoping to keep Joe-1 secret.

With so many in the U.S. military, plus the British, knowing about a confirmed Soviet nuclear explosion, Truman chose to make a public announcement. The revelation was necessary to build public support for military expenditures, reversing the austerity trend of postwar defense budgets, in order to meet the perceived threat posed by loss of the United States nuclear monopoly. Providing a substantive justification for its mission, the intelligence scoop of Joe-1's detection electrified Air Force leadership, giving the service a particular reason to see benefit in such an announcement, while also suggesting keeping the event secret would be a fruitless enterprise. Subsequently, the Air Force's intense interest in thermonuclear weapons, the need it saw for a rapid expansion of its forces, and the aggressive tone of its commanders conference at Ramey Air Force Base, Puerto Rico in the spring of 1950 the week after NSC 68 was promulgated all sprang from the service's embrace of nuclear power as its foundational prime directive. Funding an appropriate response to the Soviet advance necessitated its public recognition by the United States.

On 23 September 1949, Truman's statement that "…within recent weeks an atomic explosion had occurred within the USSR…" was issued to the press, revealing not just the existence of the Soviet bomb, but also implicitly acknowledging existence of the U.S. nuclear intelligence effort.[142] The vagueness of the announced timeframe was intended to conceal the precision with which AFOAT-1 was able to detect the timing and location of the blast, along with the unit's specific existence, from the Soviet Union and the U.S. public. The announcement immediately eliminated the doubts raised by the Boner Panel, firming up AFOAT-1's budget outlook along with those supporting units like the AWS associated with its mission.[143]

---

[141] Zeigler and Jacobson, *Spying without Spies*, 211.

[142] General H.S. Vandenberg to Secretary of Defense, 20 September 1949. President's Secretary's Files, Box 200, NSC-Atomic, Harry Truman Presidential Library. Quoted in Zeigler and Jacobson, *Spying without Spies*, 211.

[143] The Air Force benefited in the long term from Truman's revelation, suggesting the need for a closer study of any available documentation of what recommendations the service may have made about publicly announcing Joe-1.

Party Crasher

Circumstances which confirmed some of AEC commissioner Lewis Strauss' security concerns about coordination with the British also came into play at this time, although the problem did not become obvious until later.[144] The representative of MI6 in Washington (the British foreign intelligence liaison to the U.S. intelligence community) rotated home in early October 1949 just as the initial furor over Joe-1 settled. His replacement was Kim Philby, who was quickly brought up to date on current events, including the detection of Joe-1.[145] Even as the U.S. government maintained a strict public silence on the sources and methods used to detect Joe-1, Philby's importune presence most likely meant the Russians were quickly informed of AFOAT-1's mission and the basic details of its role in nuclear intelligence.

Philby eventually came under suspicion of spying after the 1951 defection to the Soviet Union of two of his Cambridge colleagues, Guy Burgess and Donald Maclean. The CIA supplied evidence to the British (who already had him under suspicion) about Philby's duplicity in June 1951 asking that he be immediately recalled. Thus, the agency was well aware of the fact that the secret existence of the U.S. nuclear intelligence program was likely compromised to the Soviets no later than June 1951.[146] While it was all but certain Philby revealed AFOAT-1's debris sampling operations to the Russians, there was no evidence he possessed knowledge of the krypton-85 plutonium production rate sampling program. A March 1951 memo indicated AFOAT-1 only then began to seek a change in the law to allow them to coordinate work to collect and analyze krypton-85 emissions with the British and Canadians, so details of what became the NOMINATION program were unlikely available yet to purloin.[147] Philby's betrayal would not be publicly confirmed until his own 1963 defection.

AFOAT-1, and its successor, AFTAC, were largely carefully concealed from the American public until the 1980s. In ironic contrast, between Truman's announcement and

---

[144] Zeigler and Jacobson, *Spying without Spies*, 194-195. Strauss was an infamous Anglophobe, inclined to find fault where none existed. He saw the Philby affair and other incidents of British security breaches as confirmation of his own prejudices.
[145] Ibid, 214-5.
[146] President Truman's September 1949 announcement of detection of Joe-1 after waiting to see if the Russians would declare their success raised obvious suspicions about the existence of such an effort, but it was Philby who ultimately able to provide and confirm details about the American effort against the Soviet nuclear program.
[147] Memorandum by R. C. Maude and D.L. Northrup, AFOAT/1, for Mr. Robert LeBaron, Deputy to the Secretary of Defense for Atomic Energy, "Notes on Technical Cooperation with British and Canadians in the Field of Atomic Energy Intelligence", 21 March 1951. http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB7/ae1-1.htm (accessed 21 April 2003). Goodman, *Spying on the Nuclear Bear*, 83, argued the British (and the FBI) "had grossly underestimated Soviet intelligence activities in the West."

Philby's treachery the Russians knew almost from the start the nuclear intelligence capability of the U.S. was effective – and why. Subsequent announcements of most Soviet tests by the United States, without disclosing the source of this information, regularly reinforced this fact to the Soviet Union until atmospheric testing ended by mutual agreement in 1963. The Russian response was to ignore the issues raised against it diplomatically and test anyway, given that it faced no significant domestic public pressure over its own role in fallout from testing, unlike governments in the West. These juxtapositions of secrecy about fallout, East and West, share remarkably similar spaces in terms of their mistrust of their own citizens. The most extreme example was the April 1954 AEC personnel security board hearing that stripped Robert Oppenheimer of his security clearance, in part over the bizarre charge that he was attempting to somehow impede or disarm SAC.[148] Such responses were emblematic of how both governments found the topic of fallout troubling, if for different reasons, refusing to admit publicly what they understood the other knew by furtive means.

GABRIEL: Can the United States Take Preemptive Action?

What was the basis of Air Force anxieties over fallout posing a threat to their weapons? Following detection of the first Soviet nuclear test in 1949, the Air Force pushed the Atomic Energy Commission into a race to develop thermonuclear weapons over the objections of its Oppenheimer-chaired General Advisory Committee (GAC). The AEC also initiated Project GABRIEL in 1949. Project GABRIEL specifically explored fallout as a constraint on nuclear war, with its first estimates suggesting a cumulative expended yield total of as little as 60 megatons was dangerous, even if dispersed on a global scale. With the later development of thermonuclear weapons, this level of fallout was subsequently exceeded several times on an annual basis during the era of atmospheric testing.[149] Even the premise of a study that nuclear war faced inherent limits was an alien and threatening concept to LeMay and his cohort of Air Force general officers. By 1953, GABRIEL seemed destined for oblivion, even after the cautionary limit was increased in November 1951 to 2,000 megatons.[150] This suggested

[148] This was among a number of accusations made against Oppenheimer by Air Force witnesses in 1954 more extreme than those he was formally accused of by the AEC. Chapter Two will assess this line of questioning and other indications the hearing was more "show trial" than legitimate inquiry.

[149] Hacker, *Elements of Controversy*, 181-183. These were total yields, i.e. fission plus fusion yields combined. The bulk of fallout is produced by the fission yield

[150] Ibid. It was uncertain whether LeMay was directly aware of Project GABRIEL, but there can be little doubt he would find any effort to "define 'practical limits" of nuclear war a questionable endeavor that intruded on Air Force prerogatives.

GABRIEL's calculations were revised to accommodate the premises of war planning in anticipation of massive fallout produced by thermonuclear weapons.[151] GABRIEL's basic research question about the limits of nuclear war remained anathema to the Air Force, yet the study was repurposed and folded into a separate secret compartment to continue under Project Sunshine in 1953.[152] As Oppenheimer, James Conant, and Lee DuBridge prepared to step down as the last three original members of the GAC in 1952, they wrote two statements, one for the public and one for the president, reflecting on what was achieved and the challenges facing them in the future. The statement pointedly called attention to the findings from GABRIEL.[153] Like Oppenheimer's concerns about fallout, GABRIEL's premises were something to suppress, rather than address forthrightly. Despite the findings of Project GABRIEL, the embarrassment of CASTLE BRAVO, and a growing accumulation of other factors, the Air Force's unrequited passion for high-yield thermonuclear weapons continued onward for nearly a decade afterwards, while taking down Oppenheimer and goading the Russians to match the rapid expansion of the Air Force's Strategic Air Command (SAC) as best they could with their own strategic forces.

GABRIEL's suppression, as well as Oppenheimer's ordeal, was consonant with the Air Force's initial belief it could continue to keep fallout's dual significance as a vital intelligence resource and as a potential limit on war a secret, despite the international uproar following the CASTLE BRAVO fallout incident. Oppenheimer's direct role in connection with the Project GABRIEL study remains uncertain, as do any specifics of the Air Force reaction to it given the sparse documentation available. While the continuing pursuit of thermonuclear weapons might

[151] With the first thermonuclear explosion, IVY MIKE in 1952, producing a yield of 10 megatons, a 60 megaton limit on wartime fallout suggested the possibility SAC might be asked to go to war with just six bombs. Even the revised limit of 2,000 megatons implied a war utilizing just 200 bombs with yields equivalent to IVY MIKE. While no such limit was known to have been explicitly proposed, such logic seemed to drive the accusations by several Air Force witnesses at the AEC's 1954 Oppenheimer security hearing that the scientist was bent on disarming SAC.

[152] The RAND conference appeared to be a vehicle to limit and repurpose the influence of GABRIEL, in part by subsuming it into Project Sunshine. Project Sunshine sought to document the accumulation of strontium-90 in living beings and the environment. Most infamous for its global hunt to acquire infant skeletons, Sunshine became public in 1957 as the AEC fought perceptions of fallout risk by invoking scientific authority. Sunshine was directed by Willard Libby, who later won a Nobel Prize for discovering carbon-14 dating of ancient objects. Libby also served as an AEC commissioner during most of the 1950s. The quickly rising stockpiles of both East and West soon made even the 2,000 megaton model a limited selection of potential destruction and radiation. CASTLE BRAVO's 1954 confirmation that "dry" thermonuclear weapon designs were practical along with global plutonium-239 inventories in excess of 10,000 kilograms by 1957 brought nuclear wars an order of magnitude greater within the realm of grim possibility. See Appendix B.

[153] Richard G. Hewlett and Francis Duncan, *Atomic Shield: A History of the United States Atomic Energy Commission* (Berkeley: University of California Press, 1990), 499-500, 518-519. In fact, GABRIEL continued at an even higher classification, oddly either subsumed by or as the overall umbrella under which Libby's Project Sunshine operated, depending on the reference to it.

seem like folly, given what is known now about the extent of the 1954 incident, the government's attempt to downplay the significance of its fallout fit the Air Force's pattern of trying to reserve fallout's documentation for its own benefit. The hidden hand of classification resulted in the continuing vacuum of evidence that played out as a persistently superficial treatment of fallout in analysis of nuclear strategy and various other areas of Cold War historiography.[154] The prevalent tendency to focus on subjectivities in studying the meaning and significance of fallout during the Cold War was in large part a result of the intentional suppression of empirical data about it due to its status as a vital intelligence source, but also GABRIEL's finding that fallout would impose limits on the conduct of nuclear war.

Consumer Choice and Construction of Popular Perceptions of Fallout: Marketing National Security Policy

The initial postwar image of the friendly, helpful atom, was aptly illustrated by a returnable glass beverage bottle: Tomboy soda – It's Atomic!

Figure 2: "Tomboy Soda Bottle, 1948" [155]

Popular culture, as many historians observe of the immediate post-war era, placed trust in the capacity of science to deliver a better future. Yet, "…fear works. It's what our brains remember." Fear is used to drive consumers towards a product by playing on the anxieties of

[154] "Proceedings of the Second Interdisciplinary Conference on Selected Effects of a General War," DASIAC Special Report 95 (Santa Barbara, CA: Defense Atomic Support Agency Information and Analysis Center, General Electric/TEMPO for DASA, July 1969), 48. The "vacuuming" was literal in the case of the *Fukuryu Maru*. Upon reaching port after the fallout incident, American intelligence officers met it, including at least one who hastily brought along a vacuum cleaner so they could capture remaining fallout particles for diagnostic purposes. Merrill Eisenbud described the ship's condition twenty-two days after the accident, although he incorrectly described the order of cleaning. "By this time the ship had been hosed, as you say, and scrubbed and people had gone on with vacuum cleaners." The Air Force wanted the dust samples dry, so vacuum first, then the hose down.
[155] Tomboy soda bottle, Indianapolis, Indiana (1948), author's collection.

what might happen if they do not purchase it.[156] Sales of fallout shelters, the ultimate antidote to atomic anxieties served up only minor relief as an "architecture of failure."[157] Marketing products by citing their war time effectiveness or through a reference to nuclear power connected them to the cutting edge of science and technology, seeking to persuade consumers to buy in order to link their lives to the benefits and security of the Atomic Age – or to suppress its obvious anxieties.

The image of health presented on the back of the 1948 Tomboy soda bottle was an example of the insidious penetration of nuclear positivism into postwar American culture. Embracing preparation of their off-spring for an atomic future was essential to reassuring some American parents that the brighter future promised by Tomboy soda's Midwestern appeal to atomic optimism, even accompanied by the gathering clouds of Cold War, and offered little to indicate the problems of atomic power might be greater than its perceived benefits.

The cultural fabric of the Cold War arms race was nearly seamless, given it was interlaced with an era of intense expansion of hegemonic consumer culture in the United States and projected from its shores. In ways similar to those used in marketing other products, citizen-consumers were frequently asked to "buy in" to national security policy. What seemed a perfect product to guarantee national security, nuclear weapons, due to fallout became an increasingly more difficult sale as a defective concept that threatened the user as well as the target. Elaine Tyler May observed the basis of perceived intrusion by nuclear weapons.

> The family seemed the one place where people could control their destinies…a source of meaning and security in a world run amok…[and] gone frighteningly insecure.[158]

Public response to policy initiatives was closely assessed by those in leadership, in turn serving to influence their own subsequent decisions. Eisenhower sought "candor" as a standard, but remained fearful of public reaction on many nuclear topics, with the White House files bulging with various levels of concern in flying memos between psychological strategy experts like C.D. Jackson, a director of Time-Life. The fallout incident threw them for a loop, perhaps

---

[156] Martin Lindstrom, *buy·ology: Truth and Lies About Why We Buy* (New York: Doubleday, 2008), 30, 138. Interestingly, some of the first studies using functional MRI scanning to study how emotions affect seemingly rational choices made about economic decisionmaking utilized the famous "Daisy" campaign commercial that Lyndon B. Johnson's campaign ran once against Barry Goldwater.
[157] Richard Ross, *Waiting for the End of the World* (New York: Princeton Architecture Press, 2004), 17.
[158] Tyler May, *Homeward Bound*, 17-18.

best expressed in a memo from a CIA staff representative on the Operations Coordinating Board to Elmer Staatz of the OCB discussing the futility of management of public reporting of the CASTLE BRAVO fallout incident.

> If OCB [Operations Coordinating Board] were to advise along the line of playing down the horror aspect, I doubt if success can be achieved. We should have learned from the Ivy experience that attempts to suppress unclassified information are not successful.[159]

For the historian, popular reaction to fallout provided a means to assess "buy-in" by citizens in support of national security policy in an age when open protest and effective resistance to government policy was a distinctly marginal activity. Gallup polls gave insight into what those on the OCB feared and what made Eisenhower reluctant to apply candor to the problem of thermonuclear weapons. A poll released on 9 April 1954 asked "What do you think is the most important problem facing this country today?" Some 56% thought one of several answers likely impacted by news from CASTLE BRAVO reflected their opinion.[160] Some 33% of Americans feared there was a "good chance" their community would be attacked by "hydrogen bombs."[161] By July 1954, 59% agreed there was "much danger of world war."[162] Fallout framed an alternative conception of nuclear weapons as insecure, instead of inspiring feelings of security. Public reaction to the problem of radiation created a difficult marketing challenge for those constructing American national security policies that by 1960 were dependent on nuclear weapons. Like a new drug with unpleasant effects, the United States government realized selling the public on nuclear weapons required suppressing the perceived threat of fallout, with the process of locating the Nevada Test Site (NTS) as a telling example of an attempt to redefine the fallout problem out of existence by invoking professional and scientific expertise.[163]

---

[159] Wayne G. Jackson to Elmer B. Staatz, "OCB Role re Nuclear Energy," 21 April 1954, Eisenhower Library, White House Office of the National Security Staff, OCB Central Files, Box 8.

[160] George H. Gallup, *The Gallup Poll: Public Opinion, 1935-1971* (New York: Random House, 1972), 1225. Gallup Poll question, "What do you think is the most important problem facing this country today?" surveyed 19-24 March 1954, published 9 April 1954.

[161] Ibid, 1230. Gallup Poll question, "In case of another world war, how much of a chance do you think there is of this community being attacked with hydrogen bombs?" Alternative answers were "Fair chance (24%), "Not much chance (39%), and no opinion (4%), surveyed 8-13 April 1954, published 25 April 1954.

[162] Gallup, *The Gallup Poll*, 1255. Gallup Poll question, "Would you say there is much danger of world war or not much danger?" "Not much" was the answer for 27% and 14% did not know, surveyed 2-7 July 1954, published 28 July 1954.

[163] Because radiation would inevitably drift off-site, the AEC opposed use of a continental test site except in the case of a "war emergency." The outbreak of war in Korea provided the Pentagon with the opportunity to press for a

Investigation into the "branding" and marketing of policy provides a means to assess nuclear weapons. Recent research on consumer decision-making demonstrates 90% of this process is subconscious.[164] While interrogating the archival record provides substantial data, the role of the subconscious in forging cultural history reminds us it also shared a role among those who created those documents. The subconscious affected how they might have been "sold" on certain policies, in how they feared the public would react to certain information that conflicted with what they were sold or told, and in how they could persuade the public to support their policy decisions, often based on limited or fabricated information. These conscious acts were embedded in the context of the surrounding culture, what it might accept and what it might reject for reasons both practical and political. This suggested why the OCB's efforts, as well as similar initiatives by the AEC, to rely on carefully selected sets of factual refutations of danger from fallout fell far short of their target to persuade the public. Nonetheless, they provide evidence of how the view from within the national security bureaucracy continued to regard fallout as a propaganda problem rather than a practical limitation on the use of nuclear weapons.

Nuclear Radiation: From Safe to Scary

What became in effect an implicit policy to avoid addressing questions about the long term consequences and uncertainties associated with the risks posed by left the threat posed by fallout's extraconventional effects an open question. Fear of fallout was of limited significance to shaping beliefs about radiation during the first decade of nuclear era.

Cultural evidence demonstrated fallout's surprisingly marginal role in constructing conceptions of nuclear war during the early Cold War prior to March 1954. Bowman Gum of Philadelphia, Pennsylvania produced sports trading cards, as well as more militaristic cards, such as "U.S. Navy Victories." Others included the 1954 "Power for Peace" series, a name that seemed to play on Eisenhower's "Atoms for Peace" initiative, although its subjects included a wide array of conventional weapons. Bowman's 1951 "Red Menace" series of bubblegum trading cards, a series also described on the card's back as the "Children's Crusade against Communism," profited specifically from invoking fear of nuclear weapons in a world where the United States no longer held a nuclear monopoly. Illustrating the supraconventional narrative nuclear weapons were embedded within before the outbreak of wide public concern about

---

decision on this, despite the AEC's misgivings, which led to the hasty process that certified the Nevada Test Site as "safe." Details of the decision will be discussed later in this chapter.

[164] Lindstrom, *buy·ology*, 195.

fallout, "Putting Out Atomic Fire" argued that "Fire, in fact, is one of the great dangers of an atomic attack."[165] The card's illustration showed fire personnel in fire boats desperately fighting a sea of fire.[166] This image corresponds with Lynn Eden's assessment in her 2004 work, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation*; fire was an important effect of nuclear weapons that was commonly associated with strategic bombing because of World War Two memories, but was later given short shrift in order to try to limit concerns about nuclear war in urban areas.[167] One of the more widely distributed civil defense leaflets of the Truman era, "Atomic Blast Creates Fire," reinforced the message fire was a principal threat of nuclear weapons.[168] Certainly of concern as one of the supraconventional effects, fire takes on a different, more complex meaning when used as a distraction from what the government regarded as more pernicious fears about fallout inherent in nuclear weapons.

Another example produced by Bowman Gum, "Atomic Doom," depicted a family fleeing destruction as another fiery explosion takes place in the background. [169] Except for the shape of the background explosion, nothing depicted hinted at radiation. The card's text surprisingly made no specific reference to nuclear weapons, presuming the front image conveyed adequate meaning in the limited space available on a trading card, but clearly referenced the war in Korea, as well as invoking the Cold War's echoing call to arms against "weakness."

> What can we do so that it *won't* happen? We can work to add more power to America and the United Nations. We can go all out in making the free world stronger than the communist world. And we can continue to work for peace. But the Reds must not mistake our goodwill for weakness.[170]

[165] As a military effect common to conventional and nuclear weapons, fire was linked here to blast effects by Civil Defense authorities. The primary difference between conventional explosive or incendiary weapons and nuclear weapons are the scales of supraconventional effects produced by a single weapon. I term blast and fire as supraconventional effects to differentiate them from radiation effects, which I refer to as extraconventional effects, but also to reflect that less visible radiation effects are as significant as supraconventional effects. While seemingly introducing new jargon, the terms actually clarify what was at stake in the Air Force's elision of fallout from its strategic planning process during the early Cold War.
[166] "Putting out Atomic Fire," Children's Crusade against Communism #13, (Philadelphia: Bowman Gum Inc., 1951), author's collection. Images of these trading cards, as well as those focused on other topics, are commonly available via searches at Google or Ebay, as well as on various trading card collector websites, a very useful cultural resource that extends well beyond the sports themes commonly associated with this form of collectible media.
[167] Lynn Eden, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation* (Ithaca: Cornell University Press, 2004).
[168] "Atomic Blast Creates Fire," Federal Civil Defense Administration, 1951, author's collection.
[169] "Atomic Doom," Children's Crusade Against Communism, No. 19, trading card (Philadelphia: Bowman Gum, Inc., 1951), author's collection.
[170] Ibid.

Emphasis on fire reflected several aspects of civil defense planning that directed concerns away from fallout toward more mundane forms of destruction. Given there was little the average person could do about blast effects, fire was often fixated upon as the problem most amenable to solution and thus effective in reassuring the public they could do something to protect their families. The political context of the era also implied doubters, dissenters, or the unenthusiastic – whether regarding civil defense, efforts to develop technology like thermonuclear weapons, or simply living a "trashy" lifestyle – might be engaged in giving aid and comfort to "the Reds."[171]

Other unofficial resources directed citizens away from radiation as a source of anxiety. The March 1951 issue of *Popular Science* carried advertising promoting marketing tie-ins to civil defense, including one for Harley-Davidson Hydra-Glide motorcycles, which provided a somewhat misleading message their product qualified you to "join your local civil defense program," implying a Harley rider would have a leg up over other cyclists vying to serve, despite the motorcycle's lack of protection against atomic doom of any sort, except for a helmet.

In the same issue was an article by the inimitable Michael Amrine entitled "How to Build a Family Foxhole" that specifically disclaimed a need to prioritize radiation as a threat.

> First, you should know that what is to be feared most in atomic attack is not *radiation*, but the more familiar forces of *heat* and *blast*…Don't buy a Geiger counter. Unless you're an expert, it will probably only confuse you. Don't buy a radiation "remedy." The only help for radiation injury is rest and blood transfusion.[172]

Besides the title's invocation of the oft-repeated conventional weapon trope, it also reiterated the common civil defense theme of household cleanup to limit the chance of fire. Amrine posed and quickly answered an essential question, "What should I do about radiation protection? Stop worrying." Amrine said nothing about shielding, as would inevitably figure in discussions about fallout shelters, repeating the official line based on assessment of the Hiroshima and Nagasaki

---

[171] Federal Civil Defense Agency (FCDA) and National Clean Up-Paint Up-Fix Up Bureau, *The House in the Middle* (two versions, 1953 and 1954), http://www.atomictheater.com/thehouseinthemiddle.htm. *The House in the Middle* was a classic civil defense film that focused on home improvement as a means to defeat nuclear weapons. While of questionable utility for that purpose, Andrew D. Grossman, described FCDA's wider goal in such exercises as "community mobilization." Andrew D. Grossman, *Neither Dead nor Red: Civilian Defense and American Political Development During the Early Cold War* (New York: Routledge, 2001), 70-77, 84, While steering carefully clear of the sort of political content that might suggest McCarthyism, the implications nonetheless suggested one's trashy neighbors were somehow disloyal. The film intentionally striped away the significance of fallout, a gap reinforced by the 1965 decision by civil defense officials to declare the film obsolete, which as atomictheater.com noted was due to this very failure to address fallout.

[172] Michael Amrine, "How to Build a Family Foxhole," *Popular Science*, Vol. 158, No. 3 (March 1951), 113-119, 160-162.

attacks that most of the danger was from prompt radiation, not fallout, that occurred only in locations suffering fire and blast damage to the extent survival was questionable anyway.

Amrine's message conveyed an optimistic view of humankind's ability to survive in the atomic age. Survival depended on a few practical tips any family could take action upon, an easily digestible form of nuclear "Hints from Heloise." Another article in the same issue described "How Atom-Pile Men Tame 'Hottest' Stuff," reminded readers American scientific and technical know-how controlled any threat posed by radiation.[173] Repeated implicit messages to anxious consumers conveyed a singular message. "Stop worrying!"

Confusing messages about fallout and related topics in the literature issued in the immediate aftermath of Soviet's first nuclear tests were largely attributable to a lack of national coordination in the civil defense hierarchy before 1954. Andrew Grossman attributed some of the unhelpful confusion in early civil defense messaging about radiation as due to the fact "postwar planners adapted the decentralized American state structure to fit a particular kind of postwar expansion of central-state power."[174] This dynamic was clearly illustrated in the multiple editions of "Six Survival Secrets for Atomic Attack," published under the aegis of local advertisers in many different communities. It appeared in a wide variety of formats, from brief pamphlets to playing a part in more lavishly illustrated civil defense-oriented advertising circulars. Many of the latter were published by American Radio Publications of Peoria, Illinois. A 1953 version, called *America on Guard: A Citizen's Hand Book*, was sponsored by radio station WJIM along with a local business, Michigan Sheet Metal Works, both of Lansing, Michigan.[175] Its contents reflected a wide range of national security anxieties of the time, as nuclear war represented the ultimate invocation of insecurity in order to sell a product to relieve the associated anxiety.

Of particular relevance here was these publications' strong language in support of American free enterprise, often framed as an appeal to "You – A Stockholder in U.S.A." along with statements by Eisenhower and Val Peterson, the chief of the Federal Civil Defense Administration. Radiological warfare was mentioned, citing the authority of a certain Professor [Louis N.] Ridenour of the University of Illinois who cautioned to treat it as a possible threat, with the author then clearly pointing to the disruptive powers of radiation voiced elsewhere in

[173] Michael Amrine, "How to Build a Family Foxhole," 113-119, 160-162.
[174] Grossman, *Neither Dead nor Red*, 10.
[175] *America on Guard: A Citizen's Hand Book* (Peoria: American Radio Publications, Inc., 1953), author's collection.

the fears of civil defense bureaucrats. "The primary purpose of such warfare would be the disruption of community and industrial life." "Radioactive residues" was the term preferred by the anonymous authors to "fallout" and these would prove "impossible to detect without special instruments and personnel." Certainly the ill effects they depicted were primarily social and cultural, even if driven largely by what was seen as an individual, unrealistic fear of potential health effects, not the statistically-distributed harm they imposed across populations. The booklet used a variant on a "six secrets" theme, the final one arguing "Do not spread rumors. Enough confusion will exist without adding to it." The remaining text consisted of more detailed information on various civil defense problems and a message from J. Edgar Hoover on how to help the FBI protect the nation from subversion, then yet again reminded the reader to "not circulate rumors…"[176] By providing poor, sketchy information on fallout, the government left a gap that was filled by development of a marketplace of ideas about nuclear weapons and their fallout that it then sought to suppress, hoping to displace rumor and discourage loose talk about radiation by branding such discourse as unpatriotic, if not quite subversive in itself.

While presented through business sponsorship of various kinds, the origin of the "six secrets" theme followed release in June 1950 of *The Effects of Nuclear Weapons* by the AEC, as cited in the California edition of *Survival under Atomic Attack*. Like the Detroit and privately published New York editions, all contained the "six secrets" in a centerfold or other arrangement that allowed them to be carried or posted as a reminder for easy reference in an emergency.[177] Each included a discussion of radioactivity in a far more optimistic tone than discussions later commonly encountered in civil defense literature.

The narrative reflected the official position of minimizing commentary on fallout, even as the term itself was again avoided, this time in favor of "lingering radioactivity." The text pointed readers towards continuing emphasis on supraconventional effects, but conceded the existence of extraconventional effects. "Radioactivity is the only way – besides size – in which the effects of A or H bombs are different from ordinary bombs." Then readers were reminded "we actually know much more about radioactivity and what it does to people than we know about infantile

[176] *America on Guard: A Citizen's Hand Book* (Peoria: American Radio Publications, Inc., 1953), author's collection. Louis Ridenour served as the Air Force Chief Scientist in 1950-1951 while on leave from his position as dean of the Graduate School at the University of Illinois. He played a role in the Oppenheimer affair discussed in Chapter Two.

[177] *Survival under Atomic Attack* (Sacramento: Office of Civil Defense, State of California, 1950); *Survival under Atomic Attack* (Detroit: Detroit Office of Civil Defense, 1950); and *Survival under Atomic Attack* (New York: The Spectrolux Corp., 1950).

paralysis, colds, or some other common diseases." An analogy followed, arguing radioactivity and sunburn were similar, in that a small exposure was normally not a serious problem, unless "it covers your whole body, it can make you very sick, or even sometimes cause death." Perhaps wearing a hat and sunscreen might help with both? After more discussion underplaying many aspects of radiation risk, best summarized as "you would still stand a better than even chance of making a complete recovery," the reader was informed.

> [P]eople fortunately are not very likely to be exposed to dangerous amounts of it in most atomic raids…regardless of all you may have heard or read…Thousands of bombs would have to be set off in the air before serious ground contamination would be found over really large areas…[not a single Japanese casualty] was caused by the lingering kind. Explosive [or prompt] radioactivity caused them all…We must not lose our heads just because radioactivity is reported as present."[178]

The scale of extraconventional effects was clearly governed in the human imagination by the relatively low yield of early fission weapons. Instead, for civil defense as with the Air Force, the emphasis was on the significance of the threat posed by supraconventional effects.

Beyond Bradbury's Benign Dust: Prologue to Nuclear Catastrophe

Ray Bradbury's dust might simply have been dust, but its sudden onset and ominously omnipresent ambiguity near the conclusion of *Fahrenheit 451* suggested he intended to tap the anxiety created by the threat of ill-defined nuclear destruction in order to stretch it beyond mere allusion to an obvious biblical reference and the already-familiar, in form, if not scale, of supraconventional weapons effects. It was not just popular culture; blast and fire also remained the primary bomb damage metrics used by the United States military to assess destruction. Strategic airpower's use of conventional weapons en masse in World War Two left behind images of pulverized cities, swimming in the dust of the grim, physical chaos wrought by these weapons on Hamburg, Dresden, and other cities. Similar images of Hiroshima and Nagasaki were distributed relatively quickly after the attacks even before the Japanese surrender, along with less journalistically-interesting pictures of quite similar destruction in Tokyo caused by incendiary bombs.[179] Regardless of the means, images of a destroyed Japan, including Hiroshima and Nagasaki, showed marked similarities with the destruction imposed on European cities.

[178] *Survival under Atomic Attack* (Sacramento: Office of Civil Defense, State of California, 1950), 8-24.
[179] Robert M. Graham, "Atomic Landscape (Japanese Burial Detail)" (Nagasaki, from collection of the U.S. Army Center of Military History, 1946), http://www.army.mil/media/13340.

Other than lacking the continuous piles of bricks left behind in Europe, images of supraconventional atomic destruction looked much like that wreaked by conventional weapons.

The Air Force portrayed the difference between conventional and atomic weapons as quantitative and based largely on efficiency of destruction offered by nuclear weapons, i.e. the capacity to destroy a city with a single weapon versus requiring use of thousands of conventional ones. Focusing on the large, quantitative differences between nuclear weapons and chemical explosives avoided drawing attention to their primary qualitative differentiator: the significant role of radiation in the form of fallout produced by fission (and later, by neutron induction from fusion reactions.) While the meaning of the two nuclear weapons of August 1945 demarcating the Nuclear Age from everything before remains controversial, there is now little disagreement it was the qualitative nature of these weapons that established a boundary between them and conventional weapons, between weapons profligately used and those whose use dare not be risked or repeated.

Nonetheless, while the revolutionary aspects of the U.S. entry into the "atomic age" were heralded as a scientific breakthrough resulting in victory, the results of the attacks on Hiroshima and Nagasaki shared a cultural space of destruction with conventional weapons marked by strong themes of continuity, casting nuclear weapons as simply the latest increment of destructive technology. Use of this new weapon depended upon the same marginalization of ethical and moral concern that rationalized the area bombing of civilian urban areas with conventional explosive and incendiary ordnance during World War Two. Striking evidence of this continuity was encapsulated in the first American nuclear war plan produced by Major General Lauris Norstad a little more than a month after the strikes on Hiroshima and Nagasaki. Sent to General Groves at the Manhattan Project for production planning purposes, Norstad advised that the USAAF required 123 of the new bombs, at a minimum. An attached map detailed the target list, 66 targets within the Soviet Union (at that moment ostensibly still a military ally), with an additional 22 in Manchuria, then under Soviet occupation to displace the defeated Japanese. Fifteen urban industrial areas were priority targets scheduled to be hit by three bombs each, with 39 weapons the minimum and 204 the "optimum" needed to carry out what was clearly a pre-emptive attack, given the Soviets had neither nuclear weapons or a strategic air force to deliver them. Norstad's plan also called for an additional 20 weapons to provide for various contingencies, with further options driving the optimal number to some 466 if production permitted their availability. Norstad was blunt in asserting the Air Force's desire, but in assessing the weapon there was a single omission, no mention of radiation, the single qualitative characteristic that set these weapons apart from conventional explosives.

> The characteristics of this weapon are such that it cannot be regarded as "just another bomb." These bombs are very expensive, cannot be produced in mass, require special storage conditions, require highly technical shipment and assembly procedures, and must be assembled and placed in the objective by highly skilled and specially trained personnel.[180]

In describing the context and importance of the document, Alex Wellerstein opined.

> …from the perspective of the immediate postwar, it still seems like quite a lot. And its very ambitiousness was a sign of things to come.[181]

Groves' response continued on to confirm that it was not a scientist, but another military officer who first formally suggested to the Air Force that limits applied to atomic warfare.

> …my general conclusion would be that the number of bombs indicated as required is excessive.[182]

For the Air Force, the assumption that these weapons were similar to conventional ones in all but their scale was present at its birth and would take strong evidence to overcome.

Thus, in the context when it was released as a novel in 1953, Bradbury's depiction of nuclear war in *Fahrenheit 451* bore a striking similarity in all but scale to the merciless, anonymous destruction wrought from the sky with conventional weapons familiar to those who endured it in World War Two – and apparently already imagined for the next war. Bradbury's use of the "dust to dust" imagery applied beyond the obvious, ominous biblical reference, marking it as the sort of useful literary device every writer treasures in clarifying the organization and meaning of a huge project as it draws to a close. But Bradbury's dust, even if

---

[180] Lauris Norstad to Leslie Groves, "Atomic Bomb Production," 15 September 1945, NARA Washington, DC, Correspondence "Top Secret" of the Manhattan Engineer District, 1942-1946, Microfilm Publication M1109 (1980), Roll 1, Target 4, Folder 3, "Stockpile, Storage, and Military Characteristics;" http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/.

[181] Ibid, with additional analysis and commentary by Alex Wellerstein, http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/. While the GABRIEL study would not begin until 1949, Norstad's total requirement to devastate the Soviet Union fell far short of the 60 megaton total yield limit it was later suggested should apply to such an attack to prevent significant global scale deleterious effects from fallout.

[182] Leslie Groves to Lauris Norstad, 26 September 1945, [attached to Norstad "Atomic Bomb Production" document in previous cite], NARA Washington, DC, Correspondence "Top Secret" of the Manhattan Engineer District, 1942-1946, Microfilm Publication M1109 (1980), Roll 1, Target 4, Folder 3, "Stockpile, Storage, and Military Characteristics."

one were engulfed by it, was seemingly benign, or at least not yet particularly feared by those who survived its creation. For instance, it might represent the birth of the new from the past as part of the cycle of life. Such a vision of harmless, perhaps even fertilely ominous dust raining down as the optimistic climax of a future nuclear conflict demonstrated how oblivious people were to the dangers of fallout during the first decade of nuclear power.

CASTLE BRAVO Makes Fallout a Public Policy Problem

Just a year after Bradbury's *Fahrenheit 451* was published, stark facts began leaking out about fallout. On 1 March 1954, the test shot, CASTLE BRAVO (15 megaton yield), sent lethal levels of fallout over more than 7,000 square miles surrounding the test site carved out of the atolls of the Marshall Islands in the remote Pacific Ocean. A policy debate over the meaning of fallout was already well underway within the secret institutions governing national security policy before the crisis broke into public view with the return of the fishing vessel, the *Lucky Dragon*, to its port in Japan, its entire crew sickened by their exposure to CASTLE BRAVO's fallout plume.

As it lost its cloak of official secrecy, fallout began a transition to widespread public perception of it as an unmanageable problem. In their *Washington Post* column of 27 September 1954, political gossip columnists Joseph and Stewart Alsop called attention to its uniquely novel destructive property, highlighting public recognition of the newly-realized dangers of fallout, the major extraconventional effect of nuclear weapons.[183]

> The super-super is quite different. Its radiation effects altogether transcend its blast and fire effects. A five-megaton super-super will destroy a circular area of 300 square miles by fire and blast. But it will probably expose an area of 6000 square miles to lethal radiation.[184]

Worse, the threat from fallout was practically invisible, unlike the drifts of dust portrayed by Bradbury as physically visible, but no more than ambiguously radioactive. CASTLE BRAVO translated its ethereal nature, making its intense fallout immediately tangible to the Japanese fishermen, even though its presence for the most part could only be described by means of radiation monitoring instruments.[185]

---

[184] Joseph and Stewart Alsop, "Super-Super Bombs Leave Deadly Dust," *Washington Post*, 27 September 1954.
[185] Steven L. Simon, André Bouville and Charles E. Land, "Fallout from Nuclear Weapons Tests and Cancer Risks," *American Scientist 94* (January/February 2006). While a variety of studies suggest relatively subdued observed effects from low-level fallout exposures, they are based on statistical modeling from admittedly problematic data

Addressing fallout's cumulative effects in the event of a general nuclear war on both personal and national security was another matter entirely. Something like radiation, usually possible to detect only through the act of reading a meter, that then required complex cognitive processing to establish its meaning, seemed strangely incapable of creating terror as an image. What appeared more relevant in discussing the social meaning of fallout were the effects of individual engagement with the meaning of fallout and how it would affect individuals should a nuclear war ever come to pass. In other words, did the concept of national security sustain belief in one's personal security or undermine it? In a cultural space filled by images, as described by Weart, specific ideas about fallout seemed a weak reed in analyzing the full range of effects creating nuclear fear. Images must be taken into account, but new evidence makes possible a more holistic appreciation of fallout's influence. Arguably, if exploring the power of imagery to foster and internalize nuclear fear was valuable, then exploring the juncture between that visible history and the capacity of the *absence* of an image to cloak fallout suggests useful insights, too. Unraveling secrecy's distortion of the visible effects of fallout is an opportunity to illustrate a far more dynamic role for fallout than previously described. The goal is not simply to reveal secrets, as tantalizing as some may be, but to use these new perspectives to explain the influence of the role and significance of fallout and nuclear intelligence on historical events. Turning back from CASTLE BRAVO for now, understanding its marking the ominous exit of fallout from its secret life – from absence to presence – requires further exploration.

Theories of Nuclear Fear and Deterrence

Fundamental laws of physics made fallout an indivisible part of the basic character of the hydrogen bomb, acting as an effective limit on what seemed at first like the virtually unlimited capacity of this type of weapon to unleash thermonuclear destruction.[186] Such weapons could

---

sets. Given that once fallout is dispersed in the environment it immediately becomes subject to a variety of processes that act to reconcentrate it, most such fallout models fail to account for this by assuming relatively even distributions of fallout once dispersed into the environment. A useful starting place for those with an interest in fallout modeling is Jay C. Willis, "Report on the History of Fallout Modeling," (Wright-Patterson Air Force Base: School of Engineering, Air Force Institute of Technology, 1979), 1. Willis begins, "Fallout is recognized today as an extremely lethal effect of nuclear weapons; it is presumed that the reader is aware of the scope of this phenomenon." Interestingly, Willis complained "data was often incomplete and poor quality." Thus, he does not appear to have been cognizant of AFOAT-1, relying instead on reports of close-in cloud-tracking, which would fit the context he provided in comments on page 4.

[186] Fusion weapons require a fission trigger. The trigger produces fallout in the process of initiating the thermonuclear reaction. Fusion reactions, while "cleaner" than fission reactions, nonetheless generate radioactive isotopes by neutron induction of materials swept up in the explosion. While substantial reductions are possible (90%

always be made larger, but there was no way to make them without fallout.[187] Somewhat counterfactually, if a nuclear weapon could be made without fallout, it would simply be the much larger conventional weapon the Air Force originally preferred to believe it possessed; the use of nuclear weapons in conflict would likely be, if not common, far from non-existent in the years since August 1945. With fallout, one is forced to confront the grim realities of the Bomb and the constraints it imposed on conflict.

Spencer Weart's argument about the power of images to skew the factual narrative of nuclear power was weakest precisely at the most important point he argued – since it was all but invisible, public perceptions of fallout were not based on images so much as ideas conveyed across the spectrum of human communication. Portraying the cloaked role of radiation in a photograph or other image remains artistically difficult. Despite the arguable failure of a metaphor about images to stick to something physically invisible as radiation, Weart's point certainly applied the power of images to convey depictions of the physical destruction produced by supraconventional nuclear weapon effects.

Michael Sherry noted how even the most sympathetic accounts of the bombings, like John Hersey's 1946 *Hiroshima*, suggested "symbols like the mushroom cloud substituted for realities which Americans could only understand second-hand."[188] Sherry wrote in terms of Americans' general isolation from the supraconventional horrors of twentieth-century war. Yet, his point also applied even more cogently to the hidden extraconventional risks of fallout. As factors precipitating nuclear fear, the sadly commonplace visible depictions of physical destruction actually worked to skew the cross-current of images this produced. Taken together, the misleading message to Americans was that atomic bombs were little different except in scale from the familiar destruction of far less powerful conventional munitions, a portrayal that persisted long after the first clear indications of fallout's threat emerged publicly in 1954.

Sherry made several other general points about the Cold War's nuclear nature that similarly apply to fallout's specific role in the argument here about its determinative centrality to American nuclear strategy. Sherry described how initial fear of atomic power was "transferred

---

to 95% cleaner in some cases) on an individual weapon basis, the sheer numbers of weapons likely to be used in general nuclear war would nonetheless generate cumulative fallout on a massive scale.

187 For fission weapons, a practical upper yield limit of about 500 kilotons exists due to certain physical properties of fissile material. The yield of a thermonuclear weapon is limited only by the carrying capacity of the delivery vehicle.

188 Michael Sherry, *In the Shadow of War: The United States since the 1930s* (New Haven: Yale University Press, 1995), 120.

from the bomb to the Soviets" in the process of rendering the vast expansion of American nuclear forces politically palatable to the public. The awful dependence on nuclear weapons also created problems of "morale and credibility." Both problems were aggravated and magnified by fallout. Sherry did not place the fault so much on fallout as on the generally problematic nature of nuclear weapons, citing Brodie's 1959 injunction that "One use of it [the nuclear sanction] will be fatally too many." If deterrence was the only possible use of nuclear weapons and the threat was similarly uncertainly constrained, how credible and stable was the atomic standoff?

> Yet if the threat was not credible, what use did America's atomic weapons have, and what risk did the country run of committing the fatal error of "appeasement"?[189]

This was the fork on which American nuclear strategy was spitted upon. Instead of one tine as "east" and one as "west," it was more accurate to say one tine consisted of the supraconventional effects and the other was extraconventional effects. While only nascent in its revelation of what Brodie considered the last big secret of nuclear weapons following the CASTLE BRAVO incident, eventually fallout's net effect would boomerang atomic fear from the Soviets and back onto the weapons themselves, not at all the intended direction. Likewise, efforts to normalize atomic weapons invoked their supraconventional effects to apply newly elastic ethical norms of total war to the use of nuclear weapons for strategic bombing.

Fallout as an Ethical and Legal Problem

The AEC and Pentagon shared multiple needs to suppress information about the radioactive nature of extraconventional effects, which ranged from the potential for legal liability, the AEC's initial concern, to the Pentagon's need to create a legal fiction to differentiate what it saw as legitimate use of weapons of mass destruction from illegal WMD use.[190] Arguably, the Pentagon had a formal point, given its argument that nuclear weapons fell within the bounds of internationally accepted postwar norms of warfare, in which the conduct of the war

---

[189] Sherry, *In the Shadow of War*, 134-135.

[190] The history of concerns over nuclear testing in Nevada shared the same arc of mixed portrayal as fallout did. Hewlett and Duncan, *Atomic Shield*, 534-535, made the standard argument used during the early Cold War that the Korean War represented an emergency requiring its use despite an earlier 1949 AEC finding otherwise opposing such testing upwind of populated areas and that the AEC's General Advisory Committee gave a "hearty approval" to the decision to proceed. By the 1989 publication of the next volume in this series by Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989), 145, it was noted that by 1953 testing in the continental United States was referred to as "a rather dangerous and immediate reality in American life," that caused AEC Chair Lewis Strauss to harbor "second thoughts." In secret, the decision had never been as certain as it was publicly portrayed, which will be explored in depth shortly. The military's secret misgivings are described in the following segment.

by the U.S. military played both explicit and implicit preponderant roles in defining; by this yardstick, indiscriminate use of nuclear weapons against civilian populations was different only in its efficiency in comparison to essentially similar indiscriminate violence inflicted on civilians caused by conventional explosive and incendiary weapons.[191] Thus, the Air Force's argument for the utility of its nuclear weapons was dependent on the exclusion of two important factors: the general lack of critical review after World War Two of the problem of collateral civilian casualties caused by all types of weapons used in strategic bombardment, whether conventional explosive, incendiary, or nuclear; and General Leslie Groves' careful suppression of references to ethical parallels between chemical agents and biological weapons and exposures to radiation.

The Universality of Conventional Destruction and the Moral Question of Radiation

Moral issues aside, mass bombardment of civilians with conventional armament was an accepted norm in Europe long before "Little Boy" detonated over the city of Hiroshima on 6 August 1945. Thus, images found in magazines like *Life* portrayed a sanitized version of the fearsome punishment inflicted on enemy populations, suggesting a somewhat different universal norm where tolerance of destruction of civilians was established as legitimate in World War Two. Regardless of its proximate cause, first-hand accounts from returning occupation troops were reconstructed in remembrance as those involved began to put the pieces of what happened together over the decades that followed.[192] Images of Hiroshima and Nagasaki, normalized in the context of familiar destruction, operated in parallel with the United States government's intentional suppression of information about radiation effects to create a distinct public impression that nuclear weapons were simply a way to efficiently package enormous destructive potential into a single bomb. This was not coincidental, but part of a larger effort by the Pentagon to constrain hard questions about radiation effects produced by nuclear weapons as worrisomely akin to violating international norms governing chemical weapons.

A recent article by Sean Malloy pointed out fear of eventual public reaction caused General Leslie Groves, military commander of the Manhattan Project, to actively work to shape

[191] The March 1945 firebombing raid on Tokyo killed and wounded more civilians in a single night solely with conventional incendiary devices than the single bombs that hit Hiroshima or Nagasaki. http://www.historylearningsite.co.uk/fire_raids_on_japan.htm.

[192] Greg Mitchell, "The Great Hiroshima Cover-Up—And the Greatest Movie Never Made," *The Asia-Pacific Journal: Japan Focus*, http://japanfocus.org/-Greg-Mitchell/3581. *Life* magazine printed several iconic images of the destruction in Japan that nearly excluded human presence, but which mimicked marginally less total destruction seen in Europe from conventional bombing of cities. A far richer archive of personal photos surfaced over the years, as did an archive of captured Japanese newsreel footage and photographs.

favorable public opinion about atomic weapons by suppressing reports of radiation sickness, small numbers of which appeared in the press in the first weeks after Hiroshima and Nagasaki were bombed. Malloy found these efforts "were part of an evolving campaign by American officials to downplay or deny the fatal and lingering radiation effects inflicted by nuclear weapons."

> Indeed, despite the best efforts of Groves and his successors, radiation effects ultimately became central to the widespread understanding of nuclear weapons as uniquely terrible and have likely contributed to the formation of a nuclear "taboo" that has helped check their use since 1945.[193]

Malloy's conclusion located the origin of secrecy about fallout in the leadership and practices of the Manhattan Project, thus linking the focus on subjectivities of fallout to an extensive secret history of limiting access to factual information about fallout and problematizing the belief it was hidden primarily because it was a source of potential political and ethical embarrassment. Groves, his commanders, and their successors placed great stock in a sanitized public image of the bomb, motivated primarily by the need to keep the project secret and the potential for legal questions to arise about the bomb's effects.

During the decade after TRINITY, Groves' successors serving on the Military Liaison Committee, which coordinated the efforts of the AEC with the military's requirements continued to believe references to radiation and its risks undermined the Pentagon's efforts intended to facilitate the *conventionalization* of the bomb. Soft power advocates arguably give credit to fallout for sparking large-scale political and social mobilizations; in response, fallout quickly became a globalized concept, thus applying pressure to slow the arms race and acting as a counterforce to the Cold War's momentum towards confrontation.[194] Thus, the decades-long public relations conflict between the bomb builders and those who represented public opposition

---

193 Sean L. Malloy, "A Very Pleasant Way to Die: Radiation Effects and the Decision to Use the Atomic Bombs Against Japan," *Diplomatic History*, Volume 36, Issue 3 (June 2012), 515-545. Malloy documents how General Leslie Groves, the U.S. Army Corps of Engineers commander of the Manhattan Project, was the first in a long line of military and civilian bureaucrats who artfully downplayed the troublesome issue of radiation to policy makers.

194 Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca: Cornell University Press, 1999) made a strong, substantive case that direct diplomacy between citizens, including scientists and physicians, arguably created the space for more official expressions of common interest in preventing nuclear war. Evangelista's focus on the Pugwash Movement and International Physicians for the Prevention of Nuclear War provided a granular reflection of movements that Lawrence S. Wittner described as part of a wider, broader arc of resistance against the dangers of nuclear conflict. One of the founders of Pugwash was Eugene Rabinowitch, a longtime professor of biophysics at the University of Illinois who was also was founder and longtime editor of the *Bulletin of the Atomic Scientists*.

to nuclear weapons was framed as largely fought along subjective lines, often leaving depictions of Cold War history reduced to a struggle over morals, perceptions, and beliefs. While they certainly contributed, it remains an open question whether these popular initiatives of resistance were sufficient cause to bring about the tangential change required to end fallout and check the fatalistic momentum of the Cold War. From Weart to Wittner, the historian's emphasis remained the subjectivity of human reaction to fallout, even in the limited presence of facts and science, which largely, and sometimes purposefully, remained missing in action. It was as if people could not get to know fallout better, so everyone just decided to gossip about it.

Supraconventional versus Extraconventional Weapons Effects

Part of Brodie's concern over revelation of fallout's existence in the 1955 AEC report on CASTLE BRAVO was prompted by fallout's creation of a need to revisit his previous work on strategy, which like most such work prior to 1954 was based solely on the supraconventional effects of nuclear weapons. Brodie's views largely reflected the U.S. military's own view of nuclear weapons as simply a more efficient means of delivering destruction conventional weapons previously provided. Despite his shock at the post-CASTLE BRAVO report's public revelations about fallout, Brodie was simply among the vast majority who missed the fact that substantial revelations about fallout occurred a year earlier during the spring 1954 AEC hearing that led to revocation of Robert Oppenheimer's security clearance, even though the term itself was apparently banned from the proceedings.[195]

Thus, this work acknowledges the empirical power of the *supraconventional* effects of nuclear weapons, even while concentrating its analytic gaze across multiple networks of political and social power to focus on the more subtle but equally significant risks of *extraconventional* effects.[196] One goal is demonstrating fallout's potent, clear-cut role in the policy market failure of nuclear weapons. Fallout set boundaries on the behaviors of those who controlled nuclear weapons, who found their perceived control of nuclear weapons and the state power flowing

---

[195] While subjected to extensive redactions for security reasons, a sanitized transcript of Oppenheimer's April 1954 hearing was quickly released by the AEC in June 1954. Sixty years later, a substantially complete declassified transcript appeared in October 2014. In some 3,000 pages of testimony, largely focused on the hydrogen bomb and its discontents, the term fallout was not mentioned. Chapter Two will explain this implications of this absence.

[196] The term supraconventional is used here to make clear the distinction between those and radiation effects, while acknowledging the political elision fallout frequently suffered despite its looming presence. These *extraconventional* effects, primarily radiological effects and, secondarily, other medical effects, e.g. flash blindness, are unique to nuclear weapons. While the primary reference refers to radioactive debris and gases lofted by a nuclear explosion into the atmosphere, the category also includes gamma rays and other prompt radiation effects.

from them considerably less absolute and markedly more inflexible than initially perceived, because fallout's extraconventional effects acted as an integral limitation on the utility value of the supraconventional military effects of nuclear weapons.

Compartmentalization and Insider Knowledge

Brodie's compartmentalization from a holistic understanding of fallout's influence on the policy he studied, despite the high level clearance required for his work, was a common feature of the first decade of fallout's service as an intelligence source. While the Soviets showed few if any signs of concern their fallout was monitored by AFOAT-1, the official story of fallout's benign and inconsequential relationship to nuclear weapons served to protect fallout by regulating access to information about it under a strict "need to know" regime. Using techniques officially described under the rubric of *long range detection* (LRD), the work of AFOAT-1 began with a tall order – "detecting atomic explosions anywhere in the world." On receipt of General LeMay's memorandum recommending assignment of the mission to the Air Force, Army Chief of Staff General Dwight Eisenhower concurred with LeMay just days before the Army Air Corps became independent from the Army with the organization of the Department of Defense under the National Security Act of 1947.[197] At the very beginning of the American effort to detect Soviet nuclear explosions, two of the central characters in the uses made of long range detection, the core topic of this project, were clearly both on the same page about its need and importance to national defense. While evidence of their currency and understanding of the scope of their cognizance over time of the specifics of LRD remains sparse, both Eisenhower and LeMay were engaged in assignments that kept them aware of its vital importance throughout their careers. They serve here in the role of *social tracers* providing evidence of fallout's changing meaning within the policy making apparatus of the U.S. government.[198] While by 1955 Eisenhower and LeMay wielded the most powerful military forces in global history, what is remarkable about what might superficially seem at first to be "big man" history was the way in which fallout drained away and constrained the power presidents and generals initially believed

[197] AFTAC, *A Fifty Year History of Long Range Detection*, frontispiece, 2-4. The National Security Act of 1947 gave rise to the CIA and thus structured the American intelligence community as it is now known, as well as reorganizing the military services under a combined Department of Defense. Assignment of the nuclear intelligence mission to the Air Force reflected the service's significant institutional interest in nuclear weapons and its ownership of the aviation resources necessary to locate and collect potentially useful samples.

[198] Not a concept intended to be analyzed at length, using Eisenhower and LeMay in a way that resembles how radioactive tracers in fallout reveal insights into bomb design as social tracers is a useful literary analogy for the way in which fallout revealed the operations of networks of power in relation to nuclear strategy and weapons.

nuclear weapons afforded the military. Fallout crafted a secret counter-narrative of scientific data and knowledge, complementing from above the voices from below that were raised against nuclear weapons as documented by Wittner, Miller, and others.[199] The experiences of the president and SAC commander as related here reflected the hubris of belief that one can truly control nuclear weapons. Instead, these weapons dictated constraints on their possessors roughly equal to what was conferred by their empowerment.

Constructing National and Personal Security In Spite of Fallout

CASTLE BRAVO's raising the issue of fallout danger implicitly questioned a constructed landscape of safety and national security relied on by the nuclear weapons bureaucracy to facilitate their use of the technology, just as the impetus toward strategic bombing created its own ethical justification for that technology in the course of World War Two.[200] Following Joe-1, the AEC came under tremendous pressure to develop fusion weapons, creating political conditions, in part focused on the carefully concealed policy significance of fallout, which eventually led to the end of J. Robert Oppenheimer's career in government service.[201] The same set of contingencies also put pressure on other AEC projects.

A prime example of the struggle over fallout's meaning was the location, establishment, and operation of the Nevada Test Site (NTS) as a continental U.S. base for nuclear testing beginning in 1951.[202] The idea of a continental test site was originally the military's, based on a secret report the Joint Chiefs of Staff commissioned in 1948. That proposal was rejected by the Atomic Energy Commission unless a "national emergency" necessitated detonating nuclear devices upwind from populated areas. The Korean "police action" soon provided just the opening needed to throw caution – and fallout – to the wind.[203] From the beginning and with only the most basic of information on its potential threat in hand, the AEC's major concern about using NTS was the risk posed by fallout, which the AEC viewed as the "major constraint on

[199] Richard L. Miller and Lawrence S. Wittner play a supportive role in their citations here, but others were important in reminding another world was possible. Others of considerable utility include Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca: Cornell University Press, 1999); Philip L. Fradkin, *Fallout: An American Tragedy* (Boulder: Johnson Books, 1989); Robert A. Devine, *Blowing on the Wind: The Nuclear Test Ban Debate, 1954-1960* (New York: Oxford University Press, 1978); and John M. Fowler, ed, *Fallout: A Study of Superbombs, Strontium-90 and Survival* (New York: Basic Books, 1960).
[200] Michael Sherry's descriptive concept of technological fanaticism again seems a good fit.
[201] Oppenheimer's difficulties and dismissal provide the main topic for Chapter two.
[202] Initially called the Nevada Proving Grounds, it will be referred to in this paper by its primary Cold War acronym as the NTS, the Nevada Test Site.
[203] Hacker, *Elements of Controversy*, 40.

testing in Nevada." Tellingly, regardless of its location, the Commission noted any "test program meant risk. Absolute safety could only result from an end to testing…"[204] Likely more salient at the time of the decision, one risk that received little attention past the initial siting of NTS was that of the Russians obtaining fallout samples. It was a definite possibility, with the proposed alternative location to NTS located in the Carolinas. That near-coastal site also held the potential for fallout to drift up the coast to the populous Northeast.

While a better choice for security reasons than the Carolinas, fallout from testing in Nevada dropped radioactive debris across wide swaths of the United States.[205] Importantly, it provided a sparsely populated interval to allow the most intense radioactivity of test fallout to decay before it reached more populated areas in the Midwest and East Coast. Given later events, the AEC's initial opposition to use of NTS, followed by its later disinterest in the matter of the risks and consequences of fallout, amounted to acquiescence to the Pentagon, suggesting the military persuaded the Commission it was okay with not only liberally dose those in the military with radiation, but potentially civilians, too.[206] It also suggested the military's historical obstructionism in limiting access to fallout studies by refusing to declassify data from the time of its most intense deposition remains telling, given there appears to be little in the way of actual security concerns to prevent such a release, even as questions about the extent of the health impacts of fallout persist.

Shields Warren, who as director of the AEC's Division of Biology and Medicine earlier managed the GABRIEL study and was a central figure in setting early AEC radiation exposure policy and practice, gave his blessing to the initial operation of the NTS by chairing an informal group called the Jangle Feasibility Committee.[207] Picking figures out of the air, as seemed to be

---

[204] Hacker, *Elements of Controversy*, 91.

[205] Although the Soviet Union demonstrated nuclear capability with its first fission weapon, the capacity of sampling to provide insight into weapon design not only provided insights into U.S. capabilities, but also information that would permit the Russians to significantly advance the state of their nuclear arts. Furthermore, while high yield thermonuclear weapons were tested in the Pacific, creating another chance for the Russians to collect samples, the fission devices that triggered the fusion reaction were tested in Nevada, potentially revealing that data, too.

[206] Hacker, *Elements of Controversy*, 59, n128. Following the GREENHOUSE series one AEC rad-safe expert wrote of a military document that left him "feeling that the report favors liberally dosing the military personnel with radiation at future operations, for the purpose of eliminating undue timidity..." Original document cited as White, "Comments on: Report by Commander, JTF-3 on Completion of Operation Greenhouse," n.d., 3.

[207] The fact that "Jangle" was part of the siting committee's name was significant, in that it may explain one of the military's major unmentioned motivations for pressuring the AEC to locate the test site in Nevada. JANGLE was the code name for one of the first test series conducted at NTS in 1951, a short, two-shot series that involved a surface-contact shot (SUGAR, 1.2 kiloton, +3.5 feet) and a shallow sub-surface shot (UNCLE, 1.2 kiloton, -17 feet). The low yield devices were chosen to minimize the fallout anticipated from the close-coupling with the earth, yet were

the case with radiation exposure standards in general, the deeply-divided panel recommended allowing testing of kiloton-class devices at NTS, based on their view that the limited fallout they produced would not exceed these arbitrarily chosen standards. It should be noted that no other studies were ever conducted that raised the basic issue of whether the NTS should be used for atmospheric testing, let alone at considerably higher yields.[208] Given Warren's involvement in GABRIEL and the AEC's initial 1949 rejection of a continental test site except on an emergency basis, this suggests the premise it developed of a 60 megaton global wartime limit on fallout and the fact that anticipated testing in Nevada would come nowhere near that limit played a substantial role in the decision, given the paucity of other supporting evidence for the safety of atmospheric testing in the continental United States.

Controlling fallout at NTS depended on a strategy that relied on natural processes to dilute the dangers of fallout as it drifted across most of the continental United States. Unfortunately, a parallel range of natural processes also exist that concentrated fallout's radioactivity through bioaccumulation, global atmospheric circulation, and other means. Despite the obvious opportunities testing provided for a range of useful studies about exposure to fallout and the Pentagon's capacity to arrange for study of a vast array of military nuclear projects, it was remarkable how little experimental interest was demonstrated by either the military or the AEC in studying fallout's impact on living environments outside the laboratory during the time of atmospheric testing.[209] This suggests a token, solitary role for Project Sunshine's obsessive focus on strontium-90 as a distraction from or substitute for more substantive research.

While the AEC said little in public about its concerns over the safety of the decision forced on it by the military with what became the Nevada Test Site (NTS), it nonetheless then proceeded to treat the main problem with radioactive fallout as one of public relations, rather than public health, anticipating a thorough discussion of the issues would needlessly stir up fears

---

inevitably relatively dirty because of the resulting direct fireball contact when shot. It appeared that, like GREEN RUN at Hanford in 1949 (to be discussed), the military wanted training, research, and development opportunities for AFOAT-1's nascent seismic and other networks that enjoyed the logistical advantages of a continental U.S. location. The primary seismic system training locations were at Lowry AFB outside Denver and its advanced seismic training and R&D efforts conducted at several locations in Wyoming.

[208] The highest yield atmospheric test conducted at NTS was HOOD (74 kilotons, 5 July 1957).

[209] Karl Z. Morgan and Ken Patterson, *The Angry Genie: One Man's Walk through the Nuclear Age* (Norman: University of Oklahoma Press, 1999); Ernest Sternglass, *Secret Fallout: Low Level Radiation from Hiroshima to Three-Mile Island* (New York: McGraw-Hill, 1981). Morgan was regarded as the "father of health physics" and was a longtime AEC employee at Oak Ridge. He later turned cautionary about radiation. Sternglass raised concerns about demographic evidence of fallout across populations in the early 1960s.

among the public. The AEC was also concerned the drain on military resources due to the Korean War threatened future testing needed for weapons development.[210] Ultimately, the AEC acquiesced to what it previously viewed as the problematic demand for a continental test site, essentially allowing military and financial considerations to overrule the AEC's reluctance to use it based on the potential hazards of fallout to the civilian population. While garnering far less attention than Oppenheimer's ordeal, choosing the location of what became NTS was just as fraught with many of the same pressures to ignore the implications of fallout as the decision to pursue thermonuclear weapons and later purge the AEC's chief scientist.

Despite choice of a site near Las Vegas, Nevada for NTS, the AEC's director of military application grumbled about its limitations, "No site within the United States can be considered a completely satisfactory alternate to overseas sites…" because of the requirement to minimize fallout exposures. Limiting the maximum yield of tests conducted in Nevada, along with a program to reassure "the general public…by judicious handling of public information," were the AEC's primary means of dealing with the problems created by detonating nuclear weapons in the desert upwind of the heavily populated regions of the United States.[211] In contrast, what the AEC saw as a public relations problem in Nevada was apparently seen by the military as a public relations opportunity to demonstrate the controllable nature of nuclear power that made it "safe" for use on the battlefield. Following Paul Fackler's "initiative" as a sampler pilot at SANDSTONE, his example of an implicit claim about the relative safety of fallout exposures arising from the apparent lack of ill effects after exposure also applied to use of NTS for testing as next in a series of situations where military-sponsored or mediated events more explicitly asserted such claims. This later included the maneuver of troops across contaminated areas shortly after numerous test shots and the 1957 test of the nuclear-armed Genie air-to-air rocket just overhead of a group of volunteers.[212]

[210] Hewlett and Duncan, *Atomic Shield*, 412-413, 415-417, 424-432, 520-535,547-554, 556-566, 577-580. Numerous citations cover the pressures for increased fissile material production in depth.
[211] Hacker, *Elements of Controversy*, 39-42.
[212] Hewlett and Holl, *Atoms for Peace and War*, 144-145, 150; http://nuclearweaponarchive.org/Usa/Tests/Upshotk.html. The 1953 test series, UPSHOT-KNOTHOLE, involved some 18,000 troops from all four services and included the only test shot of the 280 mm atomic cannon, UPSHOT-KNOTHOLE GRABLE (15 kilotons, 25 May 1953). Subsequent series exposed substantially fewer personnel as the fallout issue became increasingly problematic. By the 1957 PLUMBBOB JOHN shot (1.7 kiloton, 19 July 1957), such exposures were limited to carefully controlled scenarios, included what amounted to a stunt in locating personnel at "ground zero" but thousands of feet below the test shot to demonstrate the safety of using nuclear weapons to defend cities against air attack. This incident will be discussed in detail in Chapter 4.

Once the imagined terrain of "safe" testing at NTS was constructed and approved, pressures continued to test still more powerful weapons there.[213] Los Alamos director Norris Bradbury raised questions about the standards Warren's group recommended, noting their lack of scientific basis. Bradbury worried undertaking the tests without solid predictive evidence risked the AEC's reputation if fallout moved off-site, a fact already known by the military to be a foregone conclusion with any atmospheric testing. Disingenuously, Warren's group came back with a standard raising the allowable level of airborne radiation activity to more closely reflect the likely impact of test fallout, while limiting the need to make mandatory closures when detectable radiation inevitably moved off-site.

Besides expressing concerns about pressures on military personnel at test events to take shortcuts leading to higher exposures, this change roughly coincided with the revision in GABRIEL's estimates of the maximum tolerable global yield expenditure limit for nuclear war from 60 megatons in 1949 to 2,000 megatons in 1952.[214] The AEC's concession on the theoretical limits of nuclear war apparently reflected an effort to maintain a semblance of exposure standards to meet new military requirements anticipating wide use of thermonuclear weapons and a high tolerance for fallout. The quiet burial of such concerns with the birth of Sunshine following the pledges of confidentiality extracted from researchers at the 1953 GABRIEL conference was indicative of how the military believed it could keep fallout at bay as a problem – secrecy. The problem persisted, with one exasperated AEC health division leader arguing in 1957 the military sought to ignore test organization limits, believing exposures that "might hurt other people do not to apply to Air Force personnel."[215]

Assumptions that the threat of radiation exposure from fallout should focus on relatively stronger beta and gamma radiation initially led the AEC and the military to ignore what would prove to be the most troublesome part of fallout – seemingly weak alpha activity from particles,

---

[213] Hacker, *Elements of Controversy*, 187-188. By 1955, test operations in Nevada were officially limited to "25 kilotons from 300-foot towers, 50 kilotons from 500-foot towers, and 80 kilotons from balloons or airdrops." In practice the highest yield atmospheric shots at NTS were CLIMAX (61 kilotons, 4 June 53), HOOD (74 kilotons, 5 July 1957), and SMOKY (44 kilotons, 31 August 1957). The largest shot of the last lengthy NTS series, HARDTACK II in 1958 was BLANCA, (22 kilotons, 30 October 1958), with most shots by then generating much lower yields as testing was constrained by growing concerns about off-site fallout exposures. In a reminder that yield was not everything with regard to fallout, at NTS the dirtiest shot of all was HARRY (32 kilotons, 19 May 1953). Through the end of testing there in 1958, the total radiation exposure from NTS by one method "estimated that a cumulative total of 85,000 person-roentgens of external gamma ray exposure occurred. Of this, Harry contributed 30,000 by itself. http://nuclearweaponarchive.org/Usa/Tests/Upshotk.html.
[214] Hacker, *Elements of Controversy*, 182.
[215] Ibid, 187.

but which represented a far more potent threat if inhaled or consumed.[216] In part, this focus was adopted because the crude instruments of the day were effective in measuring beta and gamma radiation, while they had difficulty accurately measuring alpha activity.[217] However, these limits were adopted mostly because the threat of alpha fallout was poorly understood by those responsible for establishing radiation exposure standards.

This problem of assumptions based on a substantive lack of data was part of the questionably named practice of what was and still is known within the industry as "rad-safe," a shortened term for radiological safety practices applied to health physics. Bart Hacker contemplated the implications of the term throughout his comprehensive tome, *Elements of Controversy*, which examined the AEC's efforts to track and limit radiological exposures during the era of atmospheric testing. Hacker observed quite plainly, in contrast to J. Samuel Walker's later assertion it never occurred, that "[t]hreshold thinking shaped early safety codes." Hacker argued "permissible exposure" was the term in common use in the 1950s, adding "social-political" to the list of other factors that exerted a powerful influence on what were supposedly strictly constructed objective standards of radiation exposure.[218] Hacker's perspective illustrated why, whatever "rad-safe" meant to those who used or heard it, it was not really based on evidence, hard science or thoroughly vetted best practices, but on a set of best guesses designed to facilitate widespread use of nuclear energy. Using the word 'safe' was undoubtedly intended to reassure workers and the public testing was supposedly conducted in *safety*, but it certainly disguised the fact that behind the scenes a political elite was choosing to determine policy and frame it with science as an acceptable level of *risk* in ways that depended on optimistic

---

[216] Hacker, *Elements of Controversy*, 61-64.

[217] This assessment is based on observation of the development of radiometric instrumentation in the 1950s. An early study of available instruments concluded that, although "…no instrument suitable for civil defense high-intensity survey work has yet been developed..." "…some of the low-intensity instruments suitable for specialized measurements are also suitable for training." James J. Wadsworth, "Civil Defense Radiological Monitoring Instruments: Specifications," Executive Office of the President, Federal Civil Defense Administration, 1-2, https://www.orau.org/ptp/pdf/CDInstrumentSpecs.pdf. As late as 1956, Bell System training materials noted it specifically developed instruments for its own employees, in part because "Instruments for detecting radiation are in short supply…"; Michigan Bell Telephone Company, "Radiation Detection and Protection Course," (January 1956), 21, author's collection. A basic problem in measuring alpha radiation was that its weakness made measuring it difficult simply because it could not penetrate human skin or the sensors of early instruments capable of measuring stronger radiation such as beta particles or gamma rays. Development of more sensitive circuits using transistors, use of specialized plastics for sensor covers, and other means led to improvements as the 1950s rolled on.

[218] Hacker, *Elements of Controversy*, 2-4. J. Samuel Walker, in *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000), 154, specifically disputes the influence of "threshold thinking," stating, "As a matter of policy, they did not apply a threshold theory to the practice of radiation protection."

assumptions that far exceeded the state of scientific certainty about the long-term effects of radiation exposure. Hacker's exposition on the use of the term rad-safe pointed to abuses of discourse frequently found in distortions of language in support of the U.S. nuclear program.

As Foucault might surmise, this manipulation of language was an internal construction of a sector of the scientific intelligentsia designed, in part, to disguise their ignorance about fallout from the public.[219] Rad-safe as a term was language about nuclear weapons designed to reassure the public – in fact, to *market* to them the concept that nuclear power in general was safe – as well as to reassure those who actually worked with nuclear energy it was utilitarian technology under human control. By extension, this logic likewise reinforced the tendency of some, including many in the Air Force, to imagine nuclear weapons could be treated as simply larger, more efficient versions of conventional weapons, thus presented no problem delivering more bomb tonnage on target could not solve, just as it did during World War Two.

GABRIEL, Military Utility, and the Surprisingly Stark Limits of Cumulative Fallout

Shields Warren's actions during the Manhattan Project prefigured his postwar decisions and marked his dive into the relatively shallow scientific basis of determining human radiation exposure standards.[220] Under Warren's direction, the GABRIEL study in 1949 first suggested cumulative nuclear explosions of 60 megatons yield or more would lead to serious contamination of the atmosphere.[221] This was a relatively large total yield within the context of the limited supply of stockpiled fission weapons available in 1949.[222] Development of thermonuclear

---

[219] Michel Foucault, "Truth and Power," in Noam Chomsky and Michel Foucault, *The Chomsky-Foucault Debates on Human Nature* (New York: The New Press, 2006),147. "…I believe one's point of reference should not be to the great model of language and signs, but rather to that of war and battle. The history that bears and determines us has the form of a war rather than that of a language – relations of power, not relations of meaning."

[220] Walker, *Permissible Dose*, 6-10. Radiation safety during the Manhattan Project was largely based on recommendations of the Advisory Committee on X-ray and Radium Protection, which in turn were based primarily on studies of the "radium girls" and x-ray technicians and other medical personnel exposed to occupational radiation. The primary symptom observed was erythema, a reddening of the skin that provided the only empirical evidence of the range of complex biological damage from low-level radiation exposure.

[221] Hacker, *Elements of Controversy*, 181. The idea for GABRIEL apparently was initiated by Lauriston S. Taylor, a researcher loaned to the AEC by the National Bureau of Standards to organize its Division of Biology and Medicine, which Warren became director of after its formation. Taylor later argued GABRIEL was directed at strontium-90 from the beginning, but this elided the original focus on defining the limits of war due to the threat posed by all cumulative fallout as documented by subsequent declassifications discussed here. Lauriston S. Taylor, *Radiation Protection Standards* (Cleveland, CRC Press, 1971), 5.

[222] Chuck Hansen, *U.S. Nuclear Weapons: The Secret History* (Arlington, TX: Orion Books, 1988), 60-61 [referred to hereafter as Hansen I]; Chuck Hansen, *The Swords of Armageddon, Version 2* (Sunnyvale, CA: Chuklea Publications, 2007), I-123; Hans M. Kristensen and Robert S. Norris, "Global Nuclear Weapons Inventories, 1945-2013," *Bulletin of the Atomic Scientists*, V. 69, No. 5 (October 2013), http://thebulletin.org/2013/september/global-nuclear-weapons-inventories-1945-2013. As early as October 1944, Robert Oppenheimer envisioned postwar

weapons after 1949 changed the premise of exceeding 60 megatons yield to a far more likely circumstance in the event of war – the first experimental thermonuclear device (IVY MIKE, 1 November 1952) alone had a yield of 10.4 megatons (or about 500 "nominal" bombs) or about one-sixth of the fallout needed to create global peril, based on Warren's 1949 prediction.[223] With the enormous yields made possible by thermonuclear weapons, virtually any significant war between combatants utilizing them bore the potential to poison the global environment with fallout in short order. Even the cumulative yield from typical vigorous Cold War era test series imposed significant risks, if the original 60 megaton limit in GABRIEL was observed.[224]

The prospect of wider public knowledge of the conclusions found in GABRIEL held the potential to effectively undermine the military utility of arsenals and the political utility of war plans that relied on use of hundreds or, as it turned out, thousands of nuclear weapons. Such dangers raised grave, fundamental doubts about the feasibility of defense planning based around the dubious strategy of the use of massive numbers of nuclear weapons, which was effectively the core strategic concept laid down in the Air Force's war plans. Shields Warren was cognizant of this troubling limitation of nuclear weapons, while at the same time he acted with substantial influence on policy decisions made to allow their testing in the atmosphere upwind of large populations. Given Warren's prominence in the bureaucracy, his established role as researcher, participant and expert observer from the wartime years on, and the specific problematizing of nuclear war the report's prediction laid out, the limits GABRIEL set on nuclear war were in stark conflict with the post-JOE-1 goals of the Air Force.[225] There would be casualties.

---

pursuit of weapons in the 100 kiloton class, achieved at GREENHOUSE in 1951. For weapons with a yield similar to that of the plutonium-239 weapon dropped on Nagasaki (20 kilotons), it would take 3,000 weapons to equal 60 megatons; for 100 kiloton weapons, it would take 600 to equal 60 megatons total yield. Since one 20 kiloton "Fat Man" could destroy any known military target at the time, the question became where can 3,000 targets be found in the USSR? 60 megatons represented only 4 CASTLE BRAVO-class thermonuclear devices. The U.S. nuclear weapon inventory was ~170 in 1949 or about 3.4 megaton total yield, most likely all of nominal or near nominal yield. The inventory grew to some 2,422 weapons in 1955, or about 47 megatons total yield if all were of nominal yield. However, emergency capability thermonuclear weapons first entered the stockpile in 1954, so the available total yield likely exceeded GABRIEL's original 60 megaton limit at or soon after that point.

[223] Hansen, *U.S. Nuclear Weapons*, 60.

[224] See Appendix D. Total yield from testing in 1958 was ~58 megatons, while the Soviets tested 83 megatons in 1961 and the U.S./USSR combined total in 1962 was a world record 152.5 megatons before the LTBT went into force in 1963.

[225] Hacker, *Elements of Controversy*, 181-182. The premise of GABRIEL was to determine the expended cumulative yield that would create a "midlethal body burden of strontium-90…[of]…10 micrograms…where widespread radioactivity would become generally hazardous." Warren was Director of the AEC's Division of Biology and Medicine, read at least some of the GABRIEL reports, and presumably exercised direct administrative and research supervision of the project. The difference between the initial 1949 GABRIEL findings of 60 megatons and 1952's 2,000 megaton estimate was driven by the need to accommodate thermonuclear weapons.

Yet Warren avoided suffering the fate of his better known colleague, J. Robert Oppenheimer. Warren appeared to read the tea leaves and adjusted his position on the matter to accommodate the shifting contingencies fallout created during the early Cold War. GABRIEL has drawn little interest among researchers, because the extant information about it remains sparse as with other empirical studies about fallout known to exist, but currently unavailable to researchers. GABRIEL's role in the narrative marked an important turning point, opening more questions than it closed. Largely ignored after being shunted aside to even greater secrecy as a compartment within Willard Libby's Project Sunshine, a long-running, largely inconclusive strontium-90 dog-and-pony show originally billed as its successor study, GABRIEL's preliminary findings suggested the idea of general nuclear war with thermonuclear weapons was a highly impractical strategy and that a large part of SAC's planned arsenal was therefore superfluous in terms of military utility.[226] At the same time, Oppenheimer, engaged with developing the use of fallout for intelligence purposes and generally familiar with GABRIEL's conclusions as chair of the AEC's General Advisory Committee, was gaining interest in the implications of the issue, which President Truman's decision to pursue the "super" effectively ignored.

On the face of it, Truman's order of silence ostensibly covered the entire thermonuclear project; in practice, it was primarily an order to set aside comment on the fatal conceptual flaw in that decision – fallout. The near-complete silence on the topic by Oppenheimer and others that persisted prior to the spring of 1954 was a product of not only fallout's use for intelligence, but also because Truman's order was applied to stem discussion of the only aspect of the weapon

[226] The mathematics of destruction GABRIEL suggested as a global limit on total wartime yield expenditure meant its findings were essentially ignored in the planning Oppenheimer objected to with profanity in 1951. While details of the plans that raised Oppenheimer's ire remain obscure, the stockpile and weapons available to the Air Force quickly exceeded the numbers GABRIEL's findings cautioned against the use of. The U.S. stockpile stood at 299 in 1950, all fission weapons of less than 100 kiloton yield; by 1955, they numbered 2,422, including a growing number of high-yield thermonuclear weapons in the 10 megaton yield range. By 1960, the American stockpile stood at an astounding 18, 638 weapons, with a cumulative yield far exceeding even the later 2,000 megaton limit the revised GABRIEL study argued represented a substantial risk to human health and genetics. Given this was a global limit, the 1960 total of 1,605 Soviet weapons were also a factor, although it was unlikely a general nuclear war would involve expenditure of every weapon available. As a matter of policy, GABRIEL's limits seemed to have little impact on size of the arsenal, but more clarity about the threat of fallout suggested restraint would be the order of the day, with only as small a fraction of the weapons used as possible. The relatively finite target list in the Soviet Union and Air Force target planners' habit of scheduling multiple strikes on most targets also suggested a considerable excess number of weapons were available due more to the availability of fissile material than concrete need. These factors will be discussed subsequently, as destructive yield expended in excess of actual need would be accompanied by excessive prompt and cumulative fallout, the fundamental cause of Robert Oppenheimer's concern about SAC war plans.

itself that was controversial. Those it applied to knew that fallout was its primary target.[227] For those under the weight of a security agreement, that bar effectively extended for a lifetime, accounting in part for the relative "gap" in Oppenheimer's personal comments on the topic to the end of his life. With window-dressing stripped away, it was clear his most consequential conflict with the Air Force was over the issue of fallout.

Exposure: Informed Consent and the "Buchenwald Touch"

Planning for the use of significant quantities of nuclear weapons to meet wartime requirements meant the military needed to understand the more immediate effects exposure to radiation would have on soldiers, sailors, and airmen, as well as to inform civil defense planners of the measures required to protect civilian populations exposed to nuclear blast and the resulting fallout. In addition, some proposed weapons systems would require military personnel to be exposed to radiation in the normal course of their duty, even in peacetime. These included support for programs to develop nuclear-powered submarines, portable nuclear reactor power plants, and, incredibly, nuclear-powered bombers. Such aircraft would utilize only minimal amounts of shielding in order to be light enough to fly, subjecting their crews to intense radiation likely to far exceed even the AEC's relatively untested exposure standards.

In April 1949, the Air Force pushed the AEC to do experimental work to serve as the basis "to tell a group of pilots that ordinary human beings had been voluntarily exposed" to as much as 150 roentgens of radiation, a figure that far exceeded the radiation exposure standards of the day.[228] Another participant in the AEC's deliberations over support for human exposure

---

[227] Oppenheimer's public comments on the matter were very limited, largely confined to quite general ones in an appearance on Eleanor Roosevelt's radio show on the need for open dialogue in both politics and science. (Chapter 2, 164-165). A speech on the perils of secrecy to policy making and effective science delivered by Oppenheimer to a closed meeting of the Council on Foreign Relations was reprinted in *Foreign Affairs* in July 1953 early in Eisenhower's administration, but this was with official review and approval. J. Robert Oppenheimer, "Atomic Weapons and American Policy," *Foreign Affairs*, Vol. 31, No. 4, http://www.foreignaffairs.com/articles/71043/j-robert-oppenheimer/atomic-weapons-and-american-policy. A useful discussion of the situation following Oppenheimer's speech and prior to formal announcement of the personnel security board hearing during the Eisenhower administration can be found here. David R. Inglis, "The H-Bomb and Disarmament Prospects," *Bulletin of the Atomic Scientists*, Vol. 10, No. 2 (February 1954), 41-45, 64.

[228] "The Federal Civil Defense Administration states that 'One should not hesitate to accept 25r over the whole body in any single 24 hour period…For repeated exposures, 25 r per day at weekly intervals for a total of 8 exposures, may be absorbed without illness of significant deterioration in health and ability.'" Michigan Bell Telephone Company, "Radiation Detection and Protection Course," (January 1956), 49, author's collection. Obviously intended for use under wartime exposures, such permissible doses ignored longer term health or genetic risks. Many "atomic veterans" exposed to radiation from testing believe their exposures were due to government's need for "guinea pigs." The early interest of the military in studies of high doses of radiation also suggested the Pentagon was more likely to tolerate high exposures than in making efforts to mitigate the fallout problem.

studies, apparently conceding both the scientific unknowns and the pressure the AEC suffered from the military, acknowledged "the problem [was] something larger than" a medical problem – it was a political problem.[229] The pressure to paper over the fallout problem gave even Shields Warren, a man once described by Merrill Eisenbud of the AEC as "patriotic enough to lie," pause; Eisenbud noted Warren's disapproval of the human exposure experiments needed for such research.[230] The Pentagon's Committee on Medical Sciences withdrew a proposal for human experimentation in the face of Warren's objections, but the proposal would later resurface, with Warren taking a more flexible position on such matters.

During a meeting in May 1950, the Committee explicitly reconsidered the experimental protocol proposal in light of the American Medical Association's guidelines on the use of human subjects issued in 1946 during the Nuremberg trials. The guidelines clearly called for informed consent by every test subject. Military officers present were troubled by this ethical requirement, with one arguing they already had already established a precedent with an "experiment involving over 200,000 people in the Nagasaki and Hiroshima areas…" in pressing Warren to change his mind and support the Air Force's proposed human subject experiments.[231] By this time, November 1950, the Korean War was underway, adding to the pressures on Warren to accept this decision.

As with his contemporaneous decision to accede to the military's "war emergency" request to locate NTS in Nevada, Warren's decision took place within the landscape of war. Joseph Hamilton, one of his researchers, wrote Warren a memo urging whatever data was needed was best obtained through animal experiments. Hamilton argued "If this is done to humans…this would have a little of the Buchenwald touch." Warren responded to efforts to gain his approval by noting, "It is not very long since we got through trying Germans for doing exactly this thing…"[232] Thus, those responsible for regulating human radiation exposures in both the AEC and the military were fully aware of the implications of Nuremberg when it came to exposure of humans to radiation, whether by direct experiment or – perhaps less consciously because of their own considerable ignorance of its threat – by exposure to fallout.

---

[229] Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York: Random House, 1999), 319-320.
[230] Ibid, 200.
[231] Ibid, 324.
[232] Ibid, 321-6.

In the odd ethical dance that went on between Shields Warren and the Air Force, outside factors apparently became the final determinant of the outcome. Scientists in the period who raised troubling questions about the direction of U.S. nuclear policy, up to and including Robert Oppenheimer, frequently either had their loyalty called into question or feared that it would be for offering their honest scientific opinion. Oppenheimer's eventual fate was to have his security clearances pulled, effectively ending his government service and sidetracking his scientific career following the hearing in 1954; the gathering storm of suspicion severely curtailed his work even before that proceeding.[233] Given the high profile such cases faced in a political atmosphere dominated by the excesses of McCarthyism, the circumstances of Warren's resignation from the AEC and his subsequent employment in 1953 as a consultant to the Aircraft Nuclear Propulsion program (run by the Air Force's School of Aviation Medicine) beg for further research, as do formal or informal reactions by the service related to his previous review of reports from GABRIEL.

While Warren objected to conducting total body irradiation on healthy volunteers, Eileen Welsome observed he "apparently saw nothing wrong with the Air Force's School of Aviation Medicine's planned research on sick cancer patients." Warren made an astonishing turnaround in his viewpoint on the ethical considerations he previously raised, making no objections to experiments on cancer patients that were clearly without medical benefit.[234] The only difference, maybe even more damning in light of what he knew about the lessons of Nuremburg, was that these test subjects often were ill, largely poor and/or people of color, rather than the healthy military or other test subjects he objected to being abused previously.[235] This reflected Warren's limited view of the scope of application of these ethical standards, one that likewise guided him to overlook the rather obvious connection between exposing huge populations to fallout and the lack of informed consent inherent in doing so. It takes little speculation to imagine blossoming McCarthyism likely contributed to Warren's weakening ethical and moral courage.

In addition to the hundreds of thousands of Japanese who became the subjects of an experiment in human radiation exposure, it was remarkable how frequently people of color , women and those of lower class status found themselves the subjects of such testing in the United States. The first group, known as "radium girls," was the subject of a long-running study

---

[233] See Chapter Three.
[234] Welsome, *The Plutonium Files*, 331.
[235] Ibid, 334.

of their radiation exposure already well into its third decade by the early 1950s.[236] The last radium dial painting plant in Illinois was only shuttered in the late 1970s.[237]

Another case also involved Joseph Hamilton, who later wrote the "Buchenwald touch" memo to Warren. A test subject was given plutonium; his financial circumstances, Hamilton feared, were so bad because of his illness he might move away, threatening loss of valuable experimental data. Hamilton asked the Army to give the man, a house painter no longer able to practice his trade, a stipend to keep him tied to the project, but the Army refused, unless the money was regarded as payment for samples of the man's feces and urine. As Peter Bacon Hales noted, the U.S nuclear program tied "the abstractions of language, social theory, and bureaucracy to mortal bodies."[238]

The first major military-sponsored radiation exposure study, conducted to support the ill-conceived nuclear-powered bomber project, incorporated another aspect of the "Buchenwald touch." It was headed by Herbert Gerstner, a former Nazi Party member smuggled out of East Germany under the auspices of the CIA's Operation Paperclip.[239] Perhaps a partial explanation of his ethical turnaround was offered by Warren in an interview, where he spoke of the era as being a "skittish time."[240] Whatever the motivation, Warren's reverses on ethical issues in the U.S. nuclear program threw into high relief the short-term usefulness of purposeful ignorance about, not just the science of fallout, but the troubling ethical considerations that should have influenced construction, testing, and potential use of such weapons in the immediate post-Nuremberg context.

Krypton-85: Crucial Revelations and Strategic Confusion

Following the scramble of activity Joe-1 initiated, AFOAT-1 entered the daily grind of monitoring samples for further evidence of fallout debris and gases from subsequent Soviet

[236] Claudia Clark, *Radium Girls: Women and Industrial Health Reform*, 1910-1935 (Chapel Hill: University of North Carolina Press, 1997).
[237] Michael Lehman, "Long Half-Life: Government Response to the Environmental Challenge of Radioactive Materials," unpublished research paper, 2002. The state of Illinois established the Illinois Department of Nuclear Safety in the wake of the Three Mile Island reactor accident to reassure the population of Chicago and others living downwind from reactors that a warning system would be in place should an accident take place. IDNS soon found it had a much larger problem on its hands in the form of a clean-up of the dying dial-painting industry centered around LaSalle, Illinois, which contaminated workers and their communities for decades.
[238] Peter Bacon Hales, *Atomic Spaces: Living on the Manhattan Project*, (Urbana: University of Illinois Press, 1999), 274-275.
[239] Welsome, *The Plutonium Files*, 332. After World War Two, PAPERCLIP brought top German scientists to the United States, to both aid U.S. programs (most notably, the ICBM and space programs) and deny their services to the Russians.
[240]Ibid, 323.

tests.[241] A more obscure but equally important part of its work was capture and analysis of krypton-85 in order to monitor the production of the primary fissile material used in nuclear weapons, plutonium-239, in the Soviet Union. A 1951 memo by Doyle Northrup of AFOAT-1 to the Deputy to the Secretary of Defense for Atomic Energy described problems facing liaison work with the British on the krypton-85 project. Northrup advised that the Congressional Joint Committee on Atomic Energy (JCAE) should be asked to "recommend the necessary changes in legislation to permit the exchange of information on production rates of krypton-85" with the British and Canadians. With the coordination of such a joint effort, Northrup asserted it was possible to estimate Soviet plutonium production within five percent of its actual value.[242] With his tentative proposal, Northrup was engaged in an attempt to woo official approval for a closer relationship between the respective nuclear intelligence services following a string of postwar incidents and security violations involving spying by those cleared by the British for work involving nuclear weapons.

Along with the fallout sampling, also controlled by AFOAT-1, the accuracy of the quantifiable estimates of Soviet strength provided by krypton-85 stood in stark contrast to the very limited intelligence available in this period on nearly every other aspect of Russian military power. There was not, however, a corresponding method useful for estimating Soviet uranium-235 production, the other fissile material commonly used in weapons. For immature nuclear programs it was easier to separate uranium-238, the preponderant isotope found in natural uranium ores, from uranium-235 by irradiating the uranium mixture in a reactor. This converts a large percentage of the uranium-235 to plutonium-239.[243] The plutonium-239 produced can then be chemically separated from the rod after it is extracted from the reactor. Further purification of the resulting mixture yields bomb grade plutonium-239 (greater than 93% pure) as fissile material. While complex, the process worked more cost-effectively with the available technology

[241] Patience was a virtue, with the waiting likely adding to the pressures on AFOAT-1 to perform. The second and third Soviet tests occurred more than two years after Joe-1 in fall 1951. Joe-4, the first Soviet test with part of its yield derived from fusion, was in August 1953 just months after the death of Stalin.

[242] Memo from AFOAT-1 to Mr. Robert LeBaron, Deputy to the Secretary of Defense for Atomic Energy, on the subject of cooperation with Britain and Canada in the field of atomic energy intelligence, 21 March 1951. National Security Archive, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB7/ae1-1.htm.

[243] Uranium-238, the preponderant isotope (~99.3%) found in natural uranium ores, does not have the fissile properties of the uranium -235 isotope, which is present in very diluted form (0.7%). Ore was processed , then subjected to *enrichment* to raise the purity of the uranium-235 derived to over 90% for weapons-grade fissile material. Uranium separation technology improved and became more widespread, however, with the high speed centrifuge program in Iran a recent example.

than producing large amounts of weapons grade uranium by other methods, which required the technically more difficult task of isotopic separation of the otherwise chemically identical constituents of uranium, the U-235 and U-238 isotopes. The Soviet nuclear program's direction largely corresponded to the plutonium-239 model, which was confirmed by AFOAT-1 analysis of bomb debris.[244] Combined with the findings of the krypton-85 monitoring program, the Air Force was able to develop reasonably accurate estimates to track the total Soviet plutonium stockpile inventory very early in the Cold War.

Ultimately, based on several false assumptions, the absence of more accurate information, and the need to justify funding the Strategic Air Command's vast expansion, Air Force intelligence analysts used this generally accurate data to argue for massive increases in the U.S. force structure to address the worst-case Soviet threat they believed the krypton-85 estimates outlined. During most of the 1950s, in the absence of better quantifiable data, the Air Force essentially argued Soviet delivery system capabilities would track the size of this stockpile in relatively close accord with American practice. That assumption resulted in persistent and significant overestimates of Soviet delivery system capabilities based on the Air Force's mistaken extrapolation from AFOAT-1's otherwise relatively accurate data on the Soviet fissile material stockpile. Discovery of these failed intelligence assumptions eventually emerged in 1957 under closer analysis supported by U-2 imagery returned by the CIA overflights of Soviet territory, when imagery began to supplant this prior nearly-exclusive reliance on the AEDS for this extraordinarily valuable and most basic vital insight into the Soviet nuclear threat.

Krypton-85: Inert Insights in Intelligence

When the U.S. nuclear monopoly faded away in the dying fireball of Joe-1 (or *Pervaya Molniya* – First Lightning – as the Russians called it), it galvanized an upward trend in defense expenditures as the Cold War deepened. Before the Strategic Air Command's "atomic shield" against the Soviet Union was declared fully operational in July 1949, achieving LeMay's initial

[244] David Holloway, *Stalin and the Bomb: The Soviet Union and Nuclear Energy, 1939-1956* (New Haven: Yale University Press, 1994), 90-93. The Soviet nuclear program discovered plutonium's use in weapons among intelligence from Soviet spying on the British program in 1943. Given that it was far more difficult to remotely detect uranium-235 production than for plutonium-239, this was an example of how interrelationships between the fallout and krypton-85 analysis programs permitted measured judgments about the Russian stockpile. Fallout analysis demonstrated Russian weapons continued to be based primarily on plutonium implosion designs, uranium production could be inferred based on the limited roles typical played by uranium in these designs. Weapon designers also favored plutonium-239, because its neutron cross section made for a smaller, more efficient weapon.

goal on taking command, the fall of mainland China to Mao Zedong's People's Liberation Army earlier in 1949 added impetus to the idea Communism was an expansive threat.

AFOAT-1 obtained its surprisingly precise estimate of Soviet plutonium production by monitoring the atmospheric loading of krypton-85, an isotope all but non-existent in nature. The amount and rate of buildup of krypton-85 in the atmosphere was measured by a process that began with cryogenic whole air liquidfication of suitable samples at multiple locations. The tiny fraction of the vapor of intelligence interest in each sample was extracted as it boiled off through a top secret manifold plumbed to the output of an otherwise standard liquid oxygen generator unit. The amount of the isotope was estimated by totaling that emitted from Allied production, minus natural decay, and subtracting that amount from the global total detected by the samples. This arrived at an accurate estimate of the remaining factor, Soviet plutonium production.[245] This crucial joint Anglo-American effort, survived the political fallout over security from the Philby affair and other incidents affecting most other aspects of nuclear cooperation during the remainder of Truman's presidency and during Eisenhower's first term. The program, called NOMINATION at first and then renamed MUSIC later on, continued jointly until 1958.[246]

The Nuclear Numbers Game and GABRIEL's Implicit Limits on War

When the GABRIEL study began in 1949, the Atomic Energy Commission (AEC) began tracking cumulative yield from testing back to the start of testing.[247] As with plutonium-239 production, such statistics were fundamental to data-driven organizations like the U.S. Air Force and to scientific endeavors like the AEC, to the extent of their capabilities. For the Air Force, a global network of sampling aircraft provided a robust, mobile capability to gather samples.[248]

---

[245] AFOAT-1, *Unit History 1947-1953*, 164-176. This describes the start-up of the B/20 program that depended on the sometimes hazardous operation of liquid oxygen production units to obtain samples of krypton-85.

[246] The United States faced criticism over its use of United Nation's trust territories it supervised in the Pacific for its high yield test shots, after the British were forced out of Australia following controversy over its testing of low yield devices due to controversy inspired in part by Hedley Marston's revelation of official duplicity about British test fallout. Marston's confrontation with the test authorities over publication of his research on iodine-131 deposition across Australia was noted in the Introduction and will be discussed again briefly in Chapter Two. While the test moratorium obviated the need for immediate implementation of the agreement, after atmospheric testing briefly resumed in 1961, the United States made use of Britain's test range on remote Christmas Island for a series of high yield shots, while the British gained access to the Nevada Test Site for underground testing.

[247] By the end of 1949, there had been just ten nuclear explosions, the three wartime shots (TRINITY, Hiroshima, Nagasaki), five subsequent U.S. tests, and the single Soviet test. While not as thoroughly documented as later tests would be, compiling the cumulative total at that point was a relatively simple task.

[248] While its mission was global, during its first decade AFOAT-1's capabilities concentrated the AEDS around the periphery of the Soviet Union for greatest effect. Efforts to technically improve the data from which intelligence was derived through techniques other than fallout sampling, continuing concerns about potential concealment of testing,

For the AEC and associated civilian agencies with an interest in fallout, like the U.S. Public Health Service, far more modest ground facilities largely limited to domestic locations provided a rather threadbare baseline of information in comparison to AFOAT-1's capabilities. With krypton-85 monitoring of Soviet fissile material production, the Pentagon's landscape of nuclear intelligence was illustrated by voluminous data on the qualities and quantities describing the Soviet weapons program. AFOAT-1 provided a constantly updated virtual snapshot of the world's military and peaceful uses of nuclear energy.[249] The estimates of annual plutonium production and cumulative stockpiles in Appendix B represent an approximation of relative strength based on evidence that was available to be detected by intelligence efforts on both sides of the conflict.[250] At the time, compilations of such information were extraordinarily secret, yet undoubtedly provided a basic scorecard for the Cold War shared among a tiny audience of top national security advisers, military commanders, and intelligence agency officials who possessed the need to know and appropriate high level clearances. Overall, the comparative data on plutonium-239 stockpiles and estimates of relative numbers of nuclear weapons presented a considerably different picture than the uncertain scenario of American weakness and peril in the face of Soviet strength often portrayed by Air Force boosters as justification for SAC's enormous investment in nuclear weapons during the Cold War.

In 1949, the United States possessed about 170 nuclear weapons, nearly all modestly refined near-copies of the weapons used against Japan in 1945. Tests at SANDSTONE the year before verified the designs of a second generation of nuclear weapons; these entered service following SANDSTONE, which tested prototypes with yields ranging from 18 to 49 kilotons. With a cumulative stockpile of approximately 550 kilograms of plutonium-239, 1949 found annual US plutonium production drift at its lowest ebb, totaling just 150 kilograms. The Soviet Union possessed a far more modest stockpile at the time of their first test that August, with an estimated 19 kilograms of plutonium-239 and just one weapon, the device tested as Joe-1, with perhaps one additional weapon. The 29:1 discrepancy ratio between the respective stockpiles for 1949 closed sharply over the course of the next few years, although the American predominance in deliverable nuclear weapons remained unassailed prior to about 1970. While General Douglas

and the rising potential for proliferation to other nations all contributed to the expansion of the AEDS. Truly global capability came with the launch of space-based surveillance systems in the early 1960s.

[249] Estimated data on fallout was provided in the 1957 and 1959 congressional fallout hearings. Conflicts within it and other uncertainties are explored in Chapter Three and Four.

[250] Based on estimates, exact quantities may differ, but larger trends and relative positions are reflected by this data.

MacArthur's saber-rattling threats to use nuclear weapons in the Korean War earned him an early retirement due to his insubordination against Harry Truman, they also goaded on North Korea's ally, the USSR, which possessed roughly 80 bomb equivalency units (BEU) by 1953.[251] In 1952, the ratio of stockpile plutonium between the United States and the Soviet Union closed to about 3:1, then after 1957, it held relatively steady around 3:1,demonstrating the United States stockpile always held a substantial lead during the early Cold War.

The four year period from 1953 to 1956 presented a somewhat different and more worrisome period, with the ratios between U.S./USSR plutonium stockpiles ranging from 2.6:1 to 2.9:1. If there was any moment of relative American nuclear "weakness" during the Cold War, this was it. Rather than being behind the Soviets or even suggesting a putative future "gap" as the Air Force later chose to describe it, this four year period represented a slight convergence between two otherwise rather parallel lines. The United States held a substantive lead in stockpiled plutonium, as well as highly enriched uranium-235, until the 1970s. Soviet production of both ramped up substantially after 1965.[252] By then, imagery set the secret, if not the public record straight, LeMay was retired, and an implicit decision to no longer maintain the substantial 3:1 lead over potentially available Russian stockpiles. LeMay's argument publicly embraced fear of American military weakness as justification for building a substantial, secret lead in nuclear weapons based on this false premise. The American position of preponderant military strength was never threatened by Soviet efforts based solely on their fissile material stockpile or nuclear weapons. By 1965, cumulative American plutonium-239 production reached nearly 53,000 kilograms, a substantial advantage over the Soviet stockpile of some 18,000 kilograms.

Putting aside the consequences of potential wartime use of these weapons inherent in such large stockpiles, the daily reality of fallout from testing as a wartime effect during peacetime was troubling for many. Yields from testing were often publicly described in vague terms, such as "Low yield" (less than 20 kilotons) or "Submegaton" (less than one megaton but more than 200 kilotons), although the specific yield of some shots was announced in a number of

---

[251] The term bomb equivalency unit (BEU) is used here to refer to the critical mass of Pu-239 required to produce a "nominal" yield, or roughly equivalent to the Nagasaki implosion weapon, or about 10 kilograms. "Critical Mass," https://www.euronuclear.org/info/encyclopedia/criticalmass.htm. Critical mass is a complex concept that goes beyond mere mass. See Hoddeson , et al, for the Manhattan Project's struggles in defining it. Alex Wellerstein offers a useful short introduction: http://blog.nuclearsecrecy.com/2015/04/10/critical-mass/.

[252] International Panel on Fissile Materials, "Global Fissile Materials Report 2010, Balancing the Books: Production and Stocks," 26, 31, 49, 59. http://fissilematerials.org/library/gfmr10.pdf.

cases.[253] Substantially complete data on test yields began trickling out in the face of declassification following the Cold War's end.[254]

With a substantially complete record of basic shot data from nuclear testing now available to researchers, it is possible to evaluate fallout trends in light of subsequent events. Generally, production of fallout is in direct relation to fission yield, although the exact mix of hundreds of isotopes potentially created varies depending on design and burst height, which affects the amount of ground debris ingested by the fireball and converted to fallout along with components of the bomb. GABRIEL's initial 1949 estimate describing fallout from 60 megatons of yield as the beginning danger point, but the Air Force's dogged push for thermonuclear weapons drastically changed the mathematics of destruction and radiation associated with nuclear weapons. The Air Force counted on the destruction offered by supraconventional effects, discounting the extraconventional radiation of fallout as strategically significant. Why?

If GABRIEL's initial limitations had been observed once thermonuclear weapons of 10 megatons or greater yield became available, such as IVY MIKE (10.4 megatons, 1 November 1952) and CASTLE BRAVO (15 megatons, 1 March 1954), this would theoretically limit their wartime use to only a handful of targets (four to six weapons for a total of 60 megatons.) Instead, the 60 megaton limit was revised sharply upward, apparently to reflect an accommodation with the realities of the Air Force's determination to equip itself with a vast arsenal of high yield thermonuclear weapons. This revision of GABRIEL's putative estimated fallout limit to 2,000 megatons (or roughly 133 weapons with the yield of CASTLE BRAVO), was still too low to satisfy the aspirations of SAC war planners, given its anticipated enormous force growth. LeMay scorned limits on the conduct of war, so was unlikely to be mollified even

[253] "Nominal Yield" is considered a device with one critical mass of material, which produces about 20 kilotons yield, roughly the same size as the Nagasaki plutonium-239 implosion device. http://nuclearweaponarchive.org/Nwfaq/Nfaq4-2.html.

[254] The Federation of American Scientists list provides a helpful recounting of the vague, varying ranges used to announce tests by the U.S. government by year at http://fas.org/nuke/guide/usa/nuclear/nv209nar.pdf. Test yields continue to be a sensitive matter. An appendix in a 2006 Department of Energy report on atmospheric testing listed test shots between 1945 and 1958. In explaining the omission of the Hiroshima and Nagasaki weapons, their yields were carefully noted, but the list itself omitted the yields of all test shots! Terence R. Fehner and F.G. Gosling, *Battlefield of the Cold War: The Nevada Test Site, Volume I, Atmospheric Nuclear Weapons Testing, 1951-1963* (Washington, DC: U.S. Department of Energy, 2006), 203-219, http://energy.gov/sites/prod/files/DOENTSAtmospheric.pdf. Wikipedia (http://en.wikipedia.org/wiki/Nuclear_weapons_testing) notes "This is usually cited as the "official" US list." Another complete version of the list including underground tests through 1992 is at http://www.nv.doe.gov/library/publications/historical/DOENV_209_REV15.pdf. The compilations of test yields that do exist are unofficial and were constructed from multiple sources of varying accuracy.

by a more than ten-fold growth in GABRIEL's suggested ceiling on the use of nuclear weapons. Following Robert Oppenheimer's departure from the GAC, GABRIEL was then largely subsumed by being folded into a program whose threat to SAC seemed far more constrained, AEC Commissioner Willard Libby's Project Sunshine. Libby concentrated on strontium-90, just one component of fallout and he avoided framing the objective of its research questions in terms of defining the limits of nuclear war. Sunshine was not without insights, but it squandered the momentum toward an educated conversation about the problem of cumulative fallout from the massed use of nuclear weapons the GAC initiated with GABRIEL.

Suggestively, the 60 megaton cumulative yield GABRIEL defined on the limit for fallout in a nuclear war happened to correspond to the approximate total yield from all American testing reached by the end of the CASTLE series, a development path to thermonuclear weapons outlined by Oppenheimer's GAC in parallel with GABRIEL. The level of total fallout produced by testing through 1954 suggests an experiment to test the hypothesis of GABRIEL by emitting the volume of fallout over a longer time while providing the opportunity to observe the consequences. Whether intended or not, exposure of the global population as experimental subjects was utilized in Project Sunshine's inquiries in the effects of strontium-90. Given the awareness raised by some like Joseph Hamilton that experimentation with radiation on non-consenting subjects carried the "Buchenwald touch," the prior example of GREEN RUN, discussed next suggested a determination to press forward with fallout research based on this premise, but to keep it even more strictly concealed. Such a scenario would account for the GAC pursuing GABRIEL's redefinition of war's limits under Oppenheimer, then backing away to subsume it under Sunshine's watchful waiting model intended to monitor the subtle signs of fallout's health impacts. Whether it was an intentional experimental transition or one recognized as implicit only long after the fact by historians, atmospheric testing in connection with these studies represented an example of mass human experimentation without consent.

From the totality of circumstances, the initial 60 megaton limit seemed to retain some intellectual force even after it was superseded by the more thermonuclear-friendly 2,000 megaton limit. GABRIEL's attempt to define the limits of nuclear war was seemingly dispensed with by the post-Oppenheimer narrowing of inquiry into fallout by the AEC to focus on Willard

Libby's Project Sunshine.[255] The pace of American atmospheric testing never exceeded 60 megatons annually and ended at just over 156 megatons total in a final spasm that seemed to demonstrate relative restraint in the face of Russian profligacy.[256] Certainly, intellectual curiosity about fallout motivated the AEC's original fallout research priorities. Thus, it was remarkable the AEC narrowed its focus to strontium-90 and for the bulk of the decade showed little further interest in the troubling, specific issue of the limits of nuclear war raised by GABRIEL. Recalibrating GABRIEL to accommodate the anticipated enormous yields of thermonuclear weapons suggested enormous pressures being brought to bear on science by imposing secrecy to mitigate the effects of fallout. However, GABRIEL's basic research question demonstrated that doubts about the implications of fallout were in motion long before CASTLE BRAVO's rain of ruin forced the question into the light of day. The Oppenheimer hearing that followed also suggested the limits of scientific inquiry, although even there the message was muted by the apparent wholesale exclusion of its mention at the hearing, a problem taken up in Chapter Three.

What seemed to be a decision by policy makers to swerve just over the 60 megaton limit (for total U.S. testing yield through 1954) by the end of the CASTLE series suggested an attempt to "prove" one way or the other that the unseen threat of fallout was inconsequential. This creation of another fallout fait accompli bore marked similarities with the siting of NTS so that fallout would be seen to "safely" drift across the United States and Paul Fackler's decision to "accidentally" bank his sampler into the radiation plume at SANDSTONE to "prove" the safety of using piloted samplers instead of drones to collect very hot samples from close in sampling. The statistical certainty of harm in large populations described by radiation epidemiology meant that any ill effects that did occur would be delayed and difficult to link back to the exposures that precipitated cancer and other illness linked to radiation. In the immediate sense, the government was right, as thousands would no more suddenly be sickened or struck dead by fallout from testing than anyone in Fackler's sampler crew was, whatever really happened that day in 1948 with the Tolono native at the SANDSTONE test series. Effectively, no distinct policy decision was made to swerve the entire planet into a global fallout plume by adding the 48 megatons of

[255] Oppenheimer left the GAC in June 1952, in part to avoid the looming confrontation that eventually resulted in his 1954 personnel security board hearing. This will be discussed in detail in Chapter Three.
[256] See Appendices B and D. Russian testing lagged far behind the pace of the Americans in terms of numbers and yield until 1961. In an aggressive "fallout offensive" during the crisis years of 1961 and 1962, the USSR expended roughly 90% of its cumulative atmospheric test yield or nearly 200 megatons!

yield expended at the CASTLE series.[257] Nonetheless, the coincidence between the GABRIEL limit in a study originally undertaken under Robert Oppenheimer's General Advisory Committee chairmanship and the cumulative yield reached by the American thermonuclear testing program planned under his oversight suggests continuing interest in the limits of nuclear war.

Calibrating[258]

A critical analytical problem for AFOAT-1 to solve was the capability to differentiate between isotopes produced by plutonium production and those potentially generated by a reactor explosion or in the normal effluvia of reactor operation as part of the effort to obtain accurate estimates. Iodine-131 was of crucial interest to AFOAT-1 in understanding Soviet bomb design, because it was part of a decay chain crucial in determining the timing of a device's detonation. However, iodine-131 was also produced in nuclear reactors during irradiation of uranium fuel rods to produce plutonium-239. The test of Joe-1 sparked many initiatives, including the Air Force's pressure on the AEC for a crash program to develop thermonuclear weapons, which eventually forced the issue of fallout to the surface.

The detection of Joe-1 resulted in efforts to further calibrate AFOAT-1's detection capabilities and evaluate the AEDS network's effectiveness under an experimental program called GREEN RUN. Carried out in December 1949 at the Hanford AEC plutonium production reservation in Washington State, GREEN RUN was part of a wider program called Operation BLUENOSE. BLUENOSE was the overall name for intentional releases of radioactive isotopes domestically for intelligence research and development purposes. In addition to the iodine-131 releases at Hanford, other experimental work at Oak Ridge, Tennessee, and at what is now known as the Idaho National Engineering and Environmental Laboratory had the objective of developing and calibrating AFOAT-1's monitoring system for krypton-85.[259] If detection of

[257] Appendix D. Total yield from all U.S. testing at the end of 1954's CASTLE series was just over 60 megatons. This included the 15 megaton BRAVO shot, originally estimated to have a lower yield, but which Dwight Eisenhower and others remarked had "surprised" the AEC. A lower yield would have kept the cumulative yield at that point below 60 megatons, suggesting there was no prior intent to specifically exceed 60 megatons. It did not, however, include fallout from Soviet testing to that point.

[258] AFOAT-1, 1954 Unit History, 13. The choice of this section heading was chosen prior to discovery of the fact that AFOAT-1 generally referred to its use of data derived from U.S. nuclear tests as "calibration" because it offered opportunities to evaluate and develop the accuracy of its long range detection network by measuring them against known values. "Records of U.S. nuclear explosions are then available for use …the general term applied to this process is 'calibration.'" Sometimes things are just that simple when it comes to classified terminology, with the only secret being the application of a commonly used definition to a secret process.

[259] Karen Hallgren, ed., "Secrets, Lies and Operation Bluenose**,"** *INEEL News*, Volume 11, No. 6 (October 2000), http://home.earthlink.net/~edinst/publications/NEWS.Oct.00.htm.

krypton-85 was the sole objective of GREEN RUN, this indicated a goal only of determining the accuracy of methods to measure Soviet plutonium production. However, GREEN RUN, in addition to the release of krypton-85 included iodine-131. This demonstrated another objective for GREEN RUN: ensuring accurate differentiation and analysis of bomb debris from samples produced by reactor emissions or meltdowns. Data derived from detection and analysis of iodine-131 and krypton-85 formed the basic radiochemical yardsticks AFOAT-1 used to qualitatively and quantitatively characterize radioactivity discovered drifting from the USSR.[260]

To produce plutonium, uranium fuel rods are inserted into production reactors and irradiated in the controlled fission reaction of the pile sufficiently to change the required percentage of uranium into plutonium while ensuring efficient reactor operation. American practice was to withdraw the "hot" fuel rods and allow them to cool for a period of ninety days or more before further processing. This interval allowed most of the iodine-131 in the fuel rods (with its short half-life of eight days, produced along with plutonium in the rods as they were irradiated) to decay into an inert gas, xenon-131. The reduction in radiation from this cooling period facilitated their handling in subsequent processing. The irradiated rods were soaked in an acid bath to break down the fuel for further chemical processing. The origin of the name, GREEN RUN, was this processing of what were considered "green" rods, i.e. those previously considered too raw yet to process. The rods were instead cooled for a much briefer period before processing, in this case only sixteen days, or about two half-lives of I-131.[261] The shorter cooling period speeding up plutonium production, but created a greater occupational and environmental hazard from the large quantities of iodine-131 it liberated.[262] The AEC's early concerns about radiation focused on relatively long-lived isotopes, so the iodine-131'a short half-life was apparently considered relatively safe when released for GREEN RUN. The problem was that, unlike the inert xenon-131 it would have decayed into if cooled longer, iodine-131 is very chemically reactive and easily picked up and integrated into living organisms by absorption, consumption, or inhalation.

---

[260] See Appendix A.

[261] Goodman, *Spying on the Nuclear Bear*, 142-143. Intelligence sources indicated that the Soviets allowed their fuel rods to cool only sixteen days, so GREEN RUN used the same interval to release the gases for this experiment to simulate Soviet practices.

[262] Given the low plutonium production numbers for 1949 in the face of detection of Joe-1, the temporary speeding up of Hanford production likely had a third goal: increased production in a time that might lead to war.

Previous descriptions of GREEN RUN connected it to nuclear intelligence efforts directed at assessing Soviet plutonium production rates.[263] However, this was only part of the story. While most of the iodine-131 (half-life 8 days) produced in fuel rods changes into xenon-131, about one percent of the iodine-131 changes to an isomer, xenon-131m. Xenon-131m is itself a radioactive isotope, instead of being a stable noble gas like other naturally occurring xenon isotopes. Xenon-131m has a half-life of twelve days, after which it decays further into ordinary xenon-131. The decay chain of iodine-131→ xenon-131m →xenon-131 provided a rather precise mechanism, with a combined twenty day half-life window of measurement, useful in determining how long ago the event that created the sample occurred. This calculation of the "age" since the sample was born was based on the relative ratio in a sample between iodine-131 and xenon-131m.[264] This phenomenon determined the length of time between the detonation of a weapon and analysis of a sample from it, as well as provided a means to differentiate between samples emanating from a reactor and those from an explosion.[265]

Richard L. Miller's account of GREEN RUN directly connected its purpose to calibrating the AEDS for bomb testing debris collection. Miller argued the military was "taken by surprise" after it detected Joe-1 and wanted to confirm whether there may have been earlier, undetected Soviet tests.[266] Because GREEN RUN was a test to refine an existing capability of the AEDS, Miller's account seemed at odds with the evidence of an already-operational system, with a global capability to issue alerts, needing only further refinement; this information was still classified and unavailable to Miller when he wrote in the 1980s.[267]

While krypton-85 is produced by both plutonium production and by nuclear explosions, it was most useful for measuring the former because of its long half-life.[268] On the other hand,

---

[263] See Zeigler and Jacobson, *Spying without Spies*, 217; Mark Goodman, "Cold War Human Radiation Experiments: A Legacy of Distrust," *APS News* (February 1996), http://www.aps.org/apsnews/articles/11351.html (accessed 23 February 2003); John Stang, "1944-1951: 727,900 curies of radioactive iodine released," *Tri-City Herald*, 29 January 1999._ http://www.tri-cityherald.com/includes/thyroid/history.html (accessed 21 February 2003).

[264] This decay chain, to the knowledge of the author, was never described in open source literature prior to his identification of it in Lehman 2003. Citations and discussion of the author's findings in regard to the isotopes involved in this section of the paper can be found in Appendix A.

[265] Samples from a reactor would show multiple age date ranges, while those from a critical mass explosion would resolved back to the same "birth" date.

[266] Miller, *Under the Cloud*, 71. Rumors of undetected Soviet testing were rampant in the 1950s, apparently spread by anonymous Air Force supporters and several of which were subsequently identified as connected to the Oppenheimer affair.

[267] Ziegler and Jacobson, *Spying without Spies*, provided this information in their 1995 monograph.

[268] Note that plutonium and krypton-85 are also produced in civilian reactors as part of normal operations. However, there were no civilian reactors in operation until later in the 1950s.

while iodine-131 (and the resulting decay of it into xenon-131m, then into xenon-131) appears to be likewise produced by both processes, it is more useful in analyzing the resulting debris from a nuclear explosion because of its shorter half-life. Better knowledge of how the two processes were related in practice was needed to evaluate the data AFOAT-1 gathered about the Soviet nuclear program. On the other hand, most accounts of the detection of Joe-1 disputed its routine nature, suggesting it was a surprise. It may be the case the origin of the tip the Russians were close to exploding their first nuclear device was from krypton-85 sampling indicating there was a reactor operating in the Soviet Union long enough to produce fissile material for at least one weapon. Given the ambiguity over the significance of this indication of fissile material possession, prediction of the exact timing of the testing of any device constructed with it would have been outside the scope of such a report. However, despite its rather general nature, given the Air Force's focus on the LRD mission this could very well account for the alert status some indicated was in effect at the time of Joe-1's detection.

Both the exact motivations for and results from GREEN RUN remain uncertain due to continuing classification, but for the AEDS as a whole, the technology of sampling and analysis acted in concert to quickly contribute to a remarkably informative picture of the balance of nuclear power between the two nuclear rivals. Subsequent to Joe-1 American politicians immediately began expressing public concerns about falling behind the Russians in nuclear strength, concealed by the subjectively inscrutable presence of what was popularly called the "iron curtain." In secret, the Joint Chiefs of Staff by means of AFOAT-1 discovered instead a far more transparent, partially-permeable barrier conveying considerable information useful in developing an accurate picture of the Soviet nuclear threat.[269] Objectively, the Atomic Energy Detection System revealed the Soviet Union's nuclear program lagged behind American capabilities and resources.[270]

NOMINATION/MUSIC Soothes Congressional Restrictions

The legal rigors of the Atomic Energy Act of 1946 (also known as the McMahon Act), complicated the Anglo-American relationship with its prohibitions on the transfer of American

[269] The most salient examples were the upcoming bomber and missile "gaps," but analytical over-reach remained a perennial feature of American Intelligence community through the Cold War and beyond. Realistically an effort to compare public invocations of Soviet strength or simply the threat of its "unknown" nature by the U.S. military in justification of its requirements versus analysis of historical US capacity to provide accurate estimates of Soviet strength versus actual Soviet strength would be a major project on its own, but one that could be productive.
[270] The relevant appendices (B and D) tell this tale of sustained American superiority. Keep in mind that Curtis Lemay, as SAC commander, sought to build a force that was massively superior to that of the Russians.

nuclear secrets to foreign nations or individuals. Citing a variety of documents, including contemporaneous CIA reports, Michael S. Goodman documented a range of estimates derived from MUSIC data based on krypton-85 sampling indicating the American arsenal was up to ten times as large as the Soviet stockpile in the early to mid-1950s. Goodman then argued that 1953's Joe-4 test, the first Soviet nuclear weapon test with a detectable thermonuclear contribution to its yield, essentially made MUSIC obsolete, given "the fusion of light elements…[made it] virtually impossible to estimate Soviet stockpiles with any degree of certainty."[271] The advent of fusion weapons did complicate krypton-85 analysis and interpretation. However, given AFOAT-1 undertook GREEN RUN in part to address the need to monitor and differentiate between the sources that created these essential intelligence isotopes, the Americans encouraged the British to sustain the effort until 1958, indicating continued intelligence value in the program. Although thermonuclear weapons and the start-up of civilian power reactors complicated the calculations, the technique gave insight into otherwise inaccessible data on the Soviet stockpile. If it had been impossible to overcome problems created by the inherent radiochemistry associated with fusion, the 1952 American test, IVY MIKE, would have been a far greater determinant to it than the 1953 Joe-4 test, because its yield (10 megatons) meant it production of krypton-85 was far larger than Joe-4's (400 kilotons). The British also did not possess the advantage AFOAT-1 had of a complete set of samples from Soviet tests, which provided a database on which to calculate and adjust for the contributions of Soviet fusion weapons to the global krypton-85 pool.

Thus, GREEN RUN should be seen as equally if not more directly tied, by virtue of its use of iodine-131 as the focus of the experiment, to the development and calibration of the procedures of bomb debris analysis by AFOAT-1. The mistaken belief that GREEN RUN was specifically a project designed to estimate the Soviet plutonium production rate appeared to spring from its position as a project in the same office that directed krypton-85 sampling, which provided the plutonium production rate estimates. While the two are deeply interrelated, these are distinct techniques that apply to different intelligence topics. If nothing else, the most basic differentiation was that iodine-131 was useful as a qualitative measure, while krypton-85 served primarily as a quantitative parameter of Soviet nuclear strength.

---

[271] Goodman, *Spying on the Nuclear Bear*, 142-150.

GREEN RUN could also be described as a "virtual" nuclear weapon. Official estimates of the size of the release vary and other isotopes, in addition to iodine-131, went up the stacks at Hanford that night. The most commonly accepted quantity for the iodine released was approximately 8,000 curies, or about 1,000 times the average daily emissions at Hanford, all of it emitted instead in one night.[272] In comparison, the Three Mile Island reactor accident in 1979 released a total of 15 to 24 curies of iodine-131.[273] There are several factors which must be taken into account in reflecting on the wisdom of the decision of the GREEN RUN experiment.

The state of scientific knowledge of the risks of human radiation exposure at the time considered iodine to be a relatively less dangerous isotope because of its short half-life.[274] The first research into iodine-131's impact on health and the environment began at Hanford in 1950, after the GREEN RUN experiment's conclusion, in part to examine concerns raised within the AEC following reviews after the release.[275] Contributing to the Commission's unease was that about twice the amount of radiation as originally intended was released by GREEN RUN; calm winds the evening of the release caused less dispersal of the isotope plume than forecast, further concentrating it in the local Hanford area.[276] Remarkably, even though large releases of iodine-131 occurred during the AEC's routine nuclear material production operations, the isotope itself was not closely monitored by the commission until 1958.[277] Inconclusive studies yielded growing concern as evidence accumulated during the 1950s, but the true extent of the problem – the bio-concentration of iodine-131 in the thyroid gland – would only be officially recognized until after the Windscale reactor fire in the United Kingdom that began on 10 October 1957. Some 670,000 gallons of milk were dumped after iodine-131 from the accident was concentrated

---

[272] Goodman, "Cold War Human Radiation Experiments: A Legacy of Distrust," *APS News* (February 1996), http://www.aps.org/publications/apsnews/199602/backpage.cfm.
[273] Washington State Department of Health. "The Release of Radioactive Materials from Hanford: 1944-1972," http://www.angelfire.com/art2/downwinder/page1.html.
[274] John W. Healy, Interview conducted on November 28, 1994 in Los Alamos, New Mexico by Dr. Darrell Fisher, https://ehss.energy.gov/ohre/roadmap/histories/0455/0455toc.html.
[275] While it came before the Korean War, used by the military to invoke "war emergency" powers to site a nuclear test range in Nevada, a similar argument, more discreetly made, appeared to apply to the "emergency" nature of conducting GREEN RUN without the usual internal reviews. This caused concern when those reviewers discovered their usual processes were circumvented.
[276] Stang, "1944-1951: 727,000 curies of radioactive iodine released," *Tri-City Herald* (Kennewick, WA), 29 January 1999.
[277] Research on iodine-131 leapt after it contaminated the milkshed around the Windscale reactor in 1957, making explicit a poorly understood pathway it provided to spread contamination from nuclear weapon to milk to child.

into it by dairy cattle feeding on grass contaminated by the isotope.[278] The Windscale event precipitated an intensive re-examination of the role of iodine by the scientific community. By 1958, scientific recognition of the risks of iodine-131 served to accelerate international public concerns raised about fallout from atmospheric testing. GREEN RUN itself would remain secret until the 1980s; the full story of the experiment still awaits further declassification of relevant AEC and AFOAT-1 documentary evidence.

Secrecy, Science, and Security

One more link between GREEN RUN and AFOAT-1 was the involvement of Walter Singlevich, who later became a key career civilian scientist with AFTAC.[279] At the time of GREEN RUN, Mr. Singlevich worked at Hanford in the environmental monitoring research program of the AEC, prior to his transfer to AFOAT-1 in 1952. [280] This move was one example of how the Air Force, in general, and AFOAT-1, in particular, apparently took to heart the difficulties that independent-minded scientists presented to the Manhattan Engineer District. Choosing candidates carefully for civilian positions within AFOAT-1, indoctrinating them into its strict security regime, and retaining them provided the organization with the scientific skills needed at its disposal. This also prevented the host of security and political issues presented by scientists prone to moving back and forth between academia and government service. Scientific contractors, such as Tracerlab, were used for specific projects, but their work was to meet specific needs and isolated them from seeing the wider context of AFOAT-1's work.

These layers of secrecy based on the "need to know" concept extended to direct supporting units, such as the Air Weather Service, other military organizations, civilian parts of the executive branch, and the diplomatic and military officials who hosted AFOAT-1 operations. Singlevich's career with AFOAT-1/AFTAC was an example of the success of methods and

---

[278] A series of three mimeographed notices were sent to local farmers following an initial oral notification by the police. The first was a printed notice dated 15 October 1957 signed by the local police superintendent emphasizing that orders to collect and dispose of all milk to prevent it from entering the human food chain would "be strictly enforced." Feeding the milk to stock was one acceptable method, as well as disposable in a trench. The two subsequent letters came from F.M. Kearns, an official with the Ministry of Agriculture, Fisheries and Food, who advised a partial lifting of the restrictions on 29 October and permission to return to normal milk operations on 23 November. Author's collection.

[279] AFTAC's *A Fifty Year Commemorative History* is dedicated to Mr. Singlevich, who passed away while still employed full-time, where he is described as a "leading expert in nuclear debris collection and analysis" on page 53.

[280] Carl C. Gamertsfelder, Interview conducted on January 19, 1995, in Knoxville, Tennessee, by Thomas J. Fisher, Jr. and Michael A. Yuffee, https://ehss.energy.gov/ohre/roadmap/histories/0467/0467a.html. Gamertsfelder noted that Hanford was not enthusiastic about the GREEN RUN, but eventually "cooperated" with the Air Force after DuPont confirmed it was covered under their contract to operate the plant.

policies of close information control the Air Force exerted on information about the environmental effects of radiation by means of its security classification program. The fact that fallout was inevitably tied to nuclear explosions and that sampling it and other isotopes of interest was logically and practically a rather obvious process required concealment of connections about the details of its mission. Even hints about the nature of the work could strongly suggest to a knowledgeable person what AFOAT-1's mission was.

Care must be taken not to conclude that AFOAT-1 specifically suppressed this information prior to 1958 (since virtually all such information was secret then.) The state of knowledge of radiation's effects on humans was unconsolidated and in a state of flux as new information became available.[281] The process of secrecy and its associated compartmentalization certainly inhibited the sharing of information between scientists working on the problem within the government. With fewer security rigors, this could have led to an earlier recognition of the dangers posed by iodine-131, but the general implicit policy of paying minimal public attention to fallout worked against such a result. Again, it was not so much a formal barrier as it was a result of circumstances arising from the secrecy associated with nuclear weapons.

NSC 68 and the 1950 Air Force Commanders Conference: Containment or Preemption?

Evidence of the impact of nuclear intelligence on Air Force planning and priorities was rapid. Revelation of Soviet mastery of the basics of nuclear weapons technology was the original goal of the AEDS. Beyond the likelihood that krypton-85 analysis contributed to the vital first detection of Joe-1, long range detection's quantification of the Russian fissile material stockpile provided concrete description of a growing threat that went far beyond that represented by a single bomb. Joe-1 prompted the Air Force's demand for a qualitative leap in American weapons design to thermonuclear weapons, which opened the door to the problematization of fallout by their capacity to produce it in great quantities.

The association of nuclear weapons with air power also reinforced internal conflict within the Department of Defense that was expressed in interservice rivalries, particularly with the

[281] There was a general consensus among radiation safety experts that the linear-no threshold theory (LNT) of the risks of radiation exposure fits the data best, although this is hardly a settled matter. LNT holds that there is damage from any dose of radiation in direct proportion to its intensity. This conflicts with so-called "threshold" theory that assumes there is an exposure level below which lesser or no damage occurs. For an accessible discussion on this disagreement, see LeRoy Moore, "Lowering the Bar," *Bulletin of the Atomic Scientists*, 58, No. 3 (May/June 2002), 28-37. Edward Teller was a sometime advocate of hormesis, the theory that low levels of radiation help strengthen genetic stocks, although there were suggestions he did this more to play devil's advocate in discussions about the risks of radiation. Teller was a vocal skeptic of LNT. Teller, 463.

Navy, which sought to carve out a niche for its own brand of nuclear-armed, carrier-based air power. Prior to Joe-1, a paradoxical combination of aggressive public talk about confrontation with the Soviets and his failure to assertively defend the Air Force's need for the huge, ocean-spanning B-36 led to the removal of General George C. Kenney, the first commander of the Strategic Air Command.[282] Kenney was replaced by General Curtis LeMay. While his removal was usually attributed to Kenney's incompetent handling of training and operational readiness of SAC, LeMay's knowledge of long range detection likely played some role in the decision to appoint him as Kenney's replacement as SAC commander.[283] LeMay's belligerent discretion about the nature of the threat was well-served by his knowledge of LRD. Kenney's statements and others strayed into political territory during election season, leading to a cautionary statement from Republican Senator Henry Cabot Lodge Jr. to leave foreign policy to the President and State Department.[284] In contrast, while LeMay was not a soft touch he was sensible enough to understand you do not undermine your bosses. Moreover, LeMay cast the need to build-up SAC as stemming from the fact the enemy was strong, which was good for the budget, but that the US must stay stronger. The latter message's appeal proved more enduring in supporting SAC's budget than Kenney's charge that the Russian's were poised to go to war.

After AFOAT-1's successful detection of Joe-1 in the fall of 1949, the Air Force found increasing traction in making a case to fund a rapid expansion of its force structure, along with significant investment in research and development of new technology, despite the austere funding climate. This included undertaking the high-priority quest for the "super," as

---

[282] "Gen. Kenney Warns Reds May Know Atomic Secret;" "Air Force Places Orders for Planes;" "Urge Air Force to Temper Talks," *Greensburg [Pennsylvania] Daily Tribune*, 7 May 1948. Daniel Ford, "B-36: Bomber at the Crossroads," Air & Space (April 1996), http://www.airspacemag.com/history-of-flight/b-36-bomber-at-the-crossroads-134062323/?all. In a speech in Bangor, Maine, Kenney argued the Soviet may already have the "atomic secret" even as the Air Force prepared to purchase more B-50 bombers, which Kenney preferred to the cumbersome B-36 scheduled to enter service the next month, June 1948. The ultimate goal was to increase the Air Force from 55 to 70 groups over the next five years, a goal that itself would be seen as too slow after Joe-1 in 1949. The Navy League and the Air Force Association would trade charges over allegations that the plane's manufacturer, Convair, won the contract only after making $6.5 million in donations to Democratic candidates by the summer of 1949. The struggle between the Air Force and Navy was complicated by Harry Truman's parsimonious defense policies during that election year, which placed former Navy Secretary and then-first Secretary of Defense James Forrestal in a difficult position managing conflicting budget and acquisition priorities between the services. Forrestal's off the record meeting with Thomas Dewey, who seemed poised to take the presidency, saw him agree to continue under a Dewey administration. Truman won, but the meeting was revealed by gossip columnist Drew Pearson, leading to Forrestal's forced resignation and eventual suicide. For the Air Force, the threat to their interests was not always from Moscow, but was sometimes just down the hall at the Pentagon.

[283] Statements made at the April 1950 Ramey AFB conference indicating that Kenney likely was not knowledgeable about long range detection will be addressed in a moment.

[284] "Gen. Kenney Warns Reds May Know Atomic Secret," Greensburg [Pennsylvania] Daily Tribune, 7 May 1948

thermonuclear weapons were conceptually known at the time. Military power was no longer a matter of simply possessing nuclear weapons, but having deliverable weapons credibly and readily available, given "stockpiling alone [was] not enough to meet the threat."[285] The arms race with the USSR began in earnest once the chase for the super was on, with a goal of expanding U.S. nuclear superiority in order to prevent the potential political, military, and social disaster of a "nuclear Pearl Harbor."[286] National Security Council Paper 68 (NSC 68) formally called for a policy of containment by virtue of a "rapid buildup" of military force in April 1950, providing the intellectual underpinning for an expansive Cold War militarism.[287]

Like Joe-1, NSC 68 offered LeMay an opportunity to exploit for SAC's benefit, but like the raw military power of nuclear weapons it, too, was eventually undermined by the constraints of fallout. An appeal to measured confrontation with the Soviet Union, the adoption of NSC 68 was fortuitous, given the imminent start of the Korean War. It also fit well with the Air Force's recasting itself as the global vanguard of American military power by means of nuclear power. With the ink hardly dry on NSC 68, the Air Force's first post-Joe-1 "commanders conference" took place at Ramey AFB in Puerto Rico in late April 1950, shortly before the outbreak of hostilities in Korea. Minutes of the conference extended for more than 500 pages. Just as Kenney had publicly argued to the detriment of his career, behind closed doors the Air Force's leadership argued to its general officers that they saw conflict with the Soviet Union as inevitable given the proven threat Soviet possession of nuclear weapons now posed. Several speakers suggested this might even extend to considering pre-emptive war against the USSR.[288] The proceedings were also driven by the Air Force's faith in nuclear weapons, already apparent in General Lauris Norstad's immediate post-war nuclear war plan against the Soviet Union, amid eager anticipation of what they saw as the advantageous military utility of exponentially higher yield thermonuclear weapons.

---

[285] Department of Defense, *Military Participation on Buster-Jangle*. 16mm, 1:17:00. Lookout Mountain Laboratory, Hollywood, CA, 1952.

[286] Bird and Sherwin, *American Prometheus*, 436. Among the earliest references to this phrase was in a 1946 book written by William L. Borden, *There Will Be No Time: The Revolution in Strategy*. In his role as an investigator for the Joint Committee on Atomic Energy, Borden led the effort to attack Oppenheimer before and after his employment by the JCAE.

[287] U.S Department of State. *Foreign Relations of the United States, 1950, National Security Affairs, Foreign Economic Policy* (Washington, DC: U.S. GPO, 1977).

[288] Records of this meeting are listed under Item 3 at *Special Collection: Some Key Documents on Nuclear Policy Issues, 1945-1990,* National Security Archive, http://www.gwu.edu/~nsarchiv/nukevault/special/index.htm.

Leading off the discussions was the Director of Air Force Intelligence, Major General Charles P. Cabell, who presented the Air Force estimate of how fast the Soviet stockpile was growing, projecting a total of 120 to 200 weapons by 1954.[289] Cabell argued "the time is fast approaching when the Soviets will possess the capability to attempt a devastating atomic attack on the United States." The main problem for the Soviets was their limited means of delivery, which depended on the TU-4, a bomber reverse-engineered from the American B-29 after examples of it fell into Soviet custody during the later stages of World War Two.[290]

While an early estimate, the specificity of Cabell's numbers strongly suggested krypton-85 monitoring was already bearing fruit. At the time, there was no other source for even imprecise numbers on the Soviet arsenal than AFOAT-1, which apparently had at least one prototype whole air collector station operating.[291] In his seminal 1982 work on the distorted history of the "Soviet estimate" in the American intelligence community, John Prados made a general reference that the only substantive categories of information available in the period up to the mid-1950s on Soviet strength were estimates of the total tonnage of Soviet fissile material and the characteristics of the weapons themselves garnered from information gleaned from Soviet testing.[292] Both of these categories of intelligence were directly derived from the efforts of AFOAT-1, confirming the key role its data played in formulating national intelligence estimates.

Taking Account of Fallout, Deterrence as a "Wasting Asset"

The take-away message of the 1950 Ramey AFB conference was that the Air Force needed to plan for a preventative war option. Implicitly arguing against the credibility of the deterrent effect of nuclear weapons, General Cabell stated Soviet acquisition of nuclear weapons meant it was "illusory" to depend on "numerical superiority" to deter the Russians, because once "the Soviets believe they have produced a sufficient quantity of atomic bombs…the danger of a

---

[289] Cabell's specific estimate of the Soviet stockpile was derived from AFOAT-1's estimate of Soviet krypton-85 emissions. The chart of fissile material production in Appendix B indicated a cumulative Soviet weapons estimate for 1954 of 114 BEU, just below the low end of Cabell's expansive estimate. Thus the tendency toward high estimates of Soviet nuclear strength by Air Force Intelligence was established early on by its commander.

[290] "Proceedings, Commanders Conference, April 25, 26, & 27, 1950, Ramey Air Force Base, Puerto Rico, Top Secret, Excerpts," http://www.gwu.edu/~nsarchiv/nukevault/special/doc03a.pdf, 2-3.

[291] Sampling of krypton-85 was done by liquefying whole air, then drawings off its constituent parts as they boiled off with rising temperature. Because it depended on monitoring the overall global level of a relatively slowly decaying isotope, measuring krypton-85 could be done with just a single station. Adding more stations across the globe provided a better, averaged reading of its presence in the atmosphere. The CIA maintained an organization focused on nuclear and other WMDs throughout the Cold War, but it, too, depended in large part on data supplied by AFOAT-1, so its estimates of Soviet stockpile strength and intentions were based on its independent analysis of the same data the Air Force produced.

[292] Prados, *The Soviet Estimate*, 22.

Soviet surprise attack against the United States will be greatly increased."[293] Major General S.E. Anderson, the Director of Plans and Operations, told the assembly that the Air Force needed to prepare to "conduct at the earliest practicable date a strategic air offensive against the elements of the Soviet war-making capability."[294] Neither of the generals spoke on the record of the issue of fallout or nuclear intelligence specifically, although as the chief of air intelligence, Gen. Cabell was clearly cognizant of the work of AFOAT-1 and the data they supplied to his analysts. Likewise, Anderson was also aware of AFOAT-1, since it was technically in his chain of command under Operations.[295] Like most of the Air Force leadership at the time, what little else they knew of fallout beyond its use for intelligence was that it was an otherwise inconsequential side effect of nuclear explosions.

Cabell remarked the Air Force's position on the Soviet estimate was a "substantially different view" than that of the Central Intelligence Agency. The CIA viewed the main threat from the USSR as subversion around its periphery, while the Air Force saw the threat as a global one, with the Soviet Union readying itself "for a military showdown with the United States."[296] While the institutional interests of the armed services viewed the threat as primarily a military one, the CIA's view tended to undercut some of the rationale for future investment in military forces in favor of a more political-economic approach conducted by diplomatic and clandestine means. Along with Joe-1, the outbreak of war in Korea following the Ramey conference resolved these executive branch conflicts over resources largely in favor of a rapid expansion of investment in military forces in the short term.

Despite the numerous strategic advantages the United States held over the USSR, Cabell cast American nuclear forces as a "wasting asset" – and apparently ineffectual as a deterrent; once the Soviets possessed enough nuclear weapons, Cabell believed a Soviet attack would be all but inevitable. The nuclear superiority U.S. forces enjoyed would offer little to no advantage

---

[293] *Proceedings, Commanders Conference, April 25, 26, & 27, 1950 Ramey Air Force Base, Puerto Rico* in Headquarters U.S. Air Force, Office of the Chief of Staff, Vice Chief of Staff Executive Service Division, General Files 1950-1953, NARA, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6 General Files 1950-1953, Box 1, 7.

[294] Ibid, 17. Technically, Anderson was in the line of command for AFOAT-1, since it was assigned to report through Operations and not Intelligence. However, AFOAT-1operational missions were often ordered and directed by the Joint Chiefs of Staff.

[295] AFOAT-1's position as a function of Operations was a form of cover for the fact that it reported to Air Force Intelligence. Some nations were reluctant to host American intelligence operations, so this dodge obviated the need for such discussions with regard to certain detachment locations.

[296] "Proceedings, Commanders Conference, April 25, 26, & 27, 1950, Ramey Air Force Base, Puerto Rico, Top Secret, Excerpts," http://www.gwu.edu/~nsarchiv/nukevault/special/doc03a.pdf, 4-5.

against a determined enemy. Effectively, both Kenney and Cabell argued that mere possession of nuclear weapons by Stalin would lead to war, because the Soviet leader was either bad at math or simply so deranged by his ideology he was willing to start a fight he was bound to lose. Cabell saw the now-lost United States nuclear monopoly as representing a crumbling of the foundation of nuclear superiority into unstable deterrence. American nuclear weapons would "no longer be the deterrent to war in the same relative degree to which it has been in the past few years." Cabell argued that "mid 1952 should be considered as the latest date by which we must be prepared to meet a Soviet attack."[297] In a nutshell, loss of the American nuclear monopoly following development of the Soviet bomb brought the viability of deterrence itself into question, as Cabell's formulation depended on technical superiority of American weapons, not on the sheer numbers that LeMay came to depend on instead. Left unsaid before Cabell's Air Force colleagues was that Cabell's timeline for confronting the Soviets was tied to pressure from the Air Force on the AEC to develop and test thermonuclear weapons by that early date. This theme of degradation of U.S. deterrence became a familiar trope, a constant theme the Air Force publicly relied on to rally its troops and Congress around its budget priorities from the time of its brief postwar nuclear monopoly through to the end of Cold War.

Despite his pessimism about Soviet intentions, Cabell noted "we are immeasurably better off in all ways…as compared with the situation of two or three years ago," a possible reference to the operational growth and initial success of AFOAT-1, as it was almost as certainly a pat on the back to LeMay for his ongoing transformation of SAC into a credible force. Still, he opined that the "lack of adequate information is nowhere so great as in the field of air technical intelligence," a broad category which included the realm of nuclear intelligence.[298] Making no direct reference to the work of AFOAT-1 and its recent success in detecting Joe-1, yet presciently pointing out the fundamental weakness in the capabilities of the AEDS as a first generation intelligence collection system, Cabell judged that the existing intelligence shortcomings primarily regarded delivery systems, thus indicating his fairly clear-cut understanding at this early date of what the Air Force's greatest intelligence gaps proved to be.

As discouraging as Cabell's intelligence briefing was, others present were even more pessimistic. General Kenney, assigned as Air University commander after his political debacle as

[297] "Proceedings, Commanders Conference, April 25, 26, & 27, 1950, Ramey Air Force Base, Puerto Rico, Top Secret, Excerpts," http://www.gwu.edu/~nsarchiv/nukevault/special/doc03a.pdf, 7-10.
[298] Ibid, 10-11.

SAC commander, insisted projected numbers for Soviet nuclear weapons were fifty percent too low and the numbers of delivery systems were similarly short of what he assessed was Soviet strength.[299] Kenney implicitly argued Cabell was not aggressive enough, demonstrating how peer pressure contributed to analytical inaccuracies in estimates by Air Force intelligence.

In 1950 both Cabell and Kenney's comments put great stock in the potential of human agents in intelligence operations, arguing American deficits in such sources within the USSR and its satellites, positioned to provide insight into Russian intentions, was the highest priority central intelligence problem. This focus within the Air Force on human intelligence (HUMINT), even as it made major investments in technical intelligence collection systems like long range detection that proved to considerably more successful, was inspired in part because of what seemed to be Soviet intelligence successes. Later typified by discovery of Kim Philby's betrayal and the Rosenberg case, both as of the conference in April 1950 yet to be uncovered, but whose threat was foretold by those already revealed, like Alger Hiss, Klaus Fuchs, and Whittaker Chambers, the obsession with human agents had much to do with the same paranoid mindset and obsession with political loyalty that Senator Joseph McCarthy was preparing to construct.[300]

In discussing the British nuclear intelligence program, Michael Goodman noted a tendency for national security leadership to obsess over the wrong factors, then cited Richard Betts in noting that "the primary problem in major strategic surprises is not intelligence warning but political disbelief."[301] Extending this argument to the illusions of belief, the Air Force leadership's problem lay not so much in its unmet aspirations for more effective human agents as it did in reading too much or too little into what would eventually prove to be fairly accurate numbers generated through AFOAT-1's krypton-85 monitoring program.[302] The problem of faulty analytical interpretation of the NOMINATION/MUSIC data stood out in retrospect because it was an anomaly in the otherwise enormously productive results from the Air Force's

[299] Letter from General George C. Kenney, Air University to Air Force Chief of Staff General Hoyt S. Vandenberg, 29 April 1950, Top Secret, http://www.gwu.edu/~nsarchiv/nukevault/special/doc03d.pdf. While Kenney's assignment to lead the Air University might seem like a promotion to academics unfamiliar with military practices, it was decidedly a demotion from command of SAC.
[300] McCarthy's 9 February 1950 speech to Republican women in Wheeling, West Virginia kicked off the campaign of anti-Communist fervor that bears his name. In it, he charged that the State Department was packed with Communists, a charge he eventually attempted to direct against the Army, leading to his own downfall.
[301] Goodman, *Spying on the Nuclear Bear*, 55-56.
[302] See Appendix A on the basics of the krypton-85 technique. The conflict between the accuracy in the collection of this data and the failure of the subsequent analysis of their meaning that then led to the bomber and missile "gaps" was a reminder that, in contrast with the cool certainty of hindsight that historians enjoy, there are few certainties in the business of intelligence and the potential for unnerving failures great with untested assumptions.

investment in AFOAT-1, which served as a successful model presaging the enormous growth of similar technical intelligence systems in other areas of American intelligence community in preference to human agents.

The conference's foreshadowing of the coming dominance of technical collection system as the basic infrastructure of the American intelligence community also suggested what later came as significant setbacks.[303] The subsequent bomber and missile "gap" controversies and the excessive build-up of U.S. strategic nuclear forces were analytic missteps that the Atomic Energy Detection System (AEDS) eventually underwrote, the results of fundamental analytical intelligence failures whose basis has been misunderstood by many historians as driven by purely institutional interests. While flogging the "gaps" worked to the benefit of the Air Force's budget to supply more hardware as legislators scrambled to counter what later proved to be a sharply inflated Soviet threat, it was data from the AEDS that provided a substantive, empirical case at the time for the erroneous estimates of Soviet strength. When that later case fell apart with new evidence the U-2 provided, the extreme secrecy associated with nuclear intelligence activities prevented public discussion of the missteps.[304] This information's centrality to first supporting, then undermining massive retaliation as the fundamental strategic policy, and the financial, political, and public health consequences posed by global scale fallout that mass employment of nuclear weapons threatened cannot be overstated. To soften the case for the significance of the manipulation of nuclear intelligence into simply poorly crafted, distorted analysis effectively argues the president lacked self-awareness, was ignorant of the strategic situation, and paid little attention to the details of his most important task as president and retired general officer, the security of the nation. The archival record, plus a recent historiography that increasingly

[303] The term technical collection systems refers to the various intelligence networks based on imagery, nuclear, electronic, and other geophysical sensing systems that swept up and recorded data for analysis. Unlike human sources, these methods can penetrate closed societies such as the Soviet Union's via remote sensing. Once space-based systems offered an alternative to the vulnerabilities of air-breathing platforms like the U-2, they became the dominant focus of American intelligence collection, While human sources or HUMINT, remains valuable, its spotty availability and coverage still suffers in comparison to the 24/7/365 nature of technical collection systems when addressing the threats posed by nation-states. On the other hand, such systems possess significant limitations in addressing terrorism, where the American weakness in HUMINT was revealed by the 9/11 attacks.

[304] Typical treatments of the "gaps" fail to explain their underlying cause, relying on the superficial explanations offered at the time to describe how they came into being. See http://www.coldwar.org/articles/50s/bomber_gap.asp and http://en.wikipedia.org/wiki/Bomber_gap. For the "bomber gap" this was primarily the sighting of a new model of Russian bomber by U.S. defense attaches at an air show. For the "missile gap" it was the launch of Sputnik 1. Neither explanation addressed the fact the Air Force had far more substantive evidence of large quantities of fissile material detected by the AEDS in hand. The Air Force's mistake was assuming the Soviets possessed the means of delivery to employ so many weapons based on the stockpile that krypton-85 analysis revealed.

establishes the case for a more activist Eisenhower presidency than previously understood, refutes that supposition.[305] Certainly the fortuitous contingency that propelled Dwight Eisenhower into office at the height of the Cold War offered many less experienced candidates, but none possessed as credible a military reputation to confront the Joint Chiefs as peers and to force them to address issues they would prefer to avoid, such as fallout.

The Air Force's persistent insistence on higher estimated numbers of Soviet weapons and delivery systems throughout the 1950s was largely based on its faith in the estimates provided by AFOAT-1 of Soviet fissile material production, which offered the only continuing, quantitative assessment of the Russian stockpile during the bulk of this era. However, the resulting high numbers the Air Force assigned to Soviet plutonium-239 production and, more importantly, its interpretation of their significance in light of what little was known about the capabilities of Soviet delivery systems, became central components in constructing the mythology of the so-called bomber and missile "gaps," both of which imposed costly, profound consequences for the nation. Whatever disappointment the Air Force had over failure to develop the glamorous-sounding, but largely mythical potential of Western human sources to penetrate the Iron Curtain, the alternative, working world of nuclear intelligence that Ziegler and Jacobson termed "spying without spies" proved a tremendously successful, if relatively mundane project in comparison, even as it operated in extraordinary secrecy at the leading edge of science and technology.[306] Many of the generals in attendance at the commanders' conference in steamy Puerto Rico in April 1950 likely had yet to hear of AFOAT-1, as it was a relatively new direct reporting unit of Headquarters, U.S. Air Force, controlled operationally by the Joint Chiefs of Staff.[307] Regardless,

---

[305] Arguments for a more activist Eisenhower have been strengthened by ongoing declassification efforts that reveal more detail about a president reticent to show his hand. For a general overview, Kenneth Osgood, *Total Cold War: Eisenhower's Secret Propaganda Battle at Home and Abroad* (Lawrence: University Press of Kansas, 2006). More specifically on the topic of nuclear war, fallout, and science, see Benjamin P. Greene, *Eisenhower, Science Advice, and the Nuclear Test-Ban Debate, 1945-1963* (Stanford: Stanford University Press,) and Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (New York: Columbia University Press, 1998).

[306] Ziegler and Jacobson, *Spying without Spies*, ix-xi.

[307] Among those kept in the dark about NOMINATION/MUSIC was General George C. Kenney, the first commander of SAC, who LeMay replaced. A letter from Kenney to General Hoyt Vandenberg following the end of the 1950 Ramey AFB commanders conference suggested Kenney was out of the loop on the krypton-85 program, because he doubted General Charles Cabell's estimates of Soviet nuclear weapons as "too small" even though Cabell, still director of Air Force intelligence, certainly had access to that info via NOMINATION/MUSIC. See: Letter from General George C. Kenney, Air University, to Air Force Chief of Staff General Hoyt S. Vandenberg, 29 April 1950, Top Secret, Record Group 341, Records of Headquarters, United States Air Force (RG 341). Entry 214, Deputy Chief of Staff, Operations, Director of Intelligence Office of Administrative Management, July 1945-Dec 1954, Box 49, 2-12900 to 2-12999. Via National Security Archive: http://www2.gwu.edu/~nsarchiv/nukevault/special/doc03d.pdf.

the officers at Ramey were already undergoing familiarization with the results of AFOAT-1's work products, as cryptically interpreted by Gen. Cabell and others.

AFOAT-1

By early 1950, the Atomic Energy Detection System (AEDS) was rapidly expanding in the immediate aftermath of the detection of Joe-1 in order to meet operational and intelligence requirements needed to track the growth of the Soviet nuclear weapons program. An organization chart in Appendix E depicts how the unit, known as both AFOAT-1 and the 1009th Special Weapons Squadron depending on the audience, was organized.[308] Indicative of the fact the Air Force continues to withhold much of its historical information for what appear to be almost capricious justifications was that the other thirty-three pages of the thirty-five pages in this basic, presumably superseded document remain security classified and unavailable.

The Air Force avoided the Manhattan District model for scientific labor and support, which largely depended on civilian scientific labor, when it conceptualized AFOAT-1's nuclear intelligence role. Under General Leslie Grove's command was a virtual army of science, in turn headed by J. Robert Oppenheimer. It was a model that retained the basic independence of scientists still familiar to those working at any large research university. Groves spent considerable effort attempting to maintain the extraordinary security the Manhattan Project required, even as the scientists involved actively chafed at such restrictions.[309] While science was necessary to develop the procedures and technology used, the direct work of civilian scientists within AFOAT-1 was limited to that of a few closely vetted managers, who could contract with outside organizations as necessary, such as the Atomic Energy Commission or contractors like Tracerlab, Inc., to provide specialized advice and consultation to the civilian scientists and military officers working in AFOAT-1. By April 1950, the unit's former Scientific Division was even renamed the Technical Division, headed by a Technical Director, who would continue to be a civilian scientist, but whose brief was clearly the technological implementation of scientific research to meet nuclear intelligence requirements. Now the only place that "science" explicitly

[308] Staff Memorandum 20-1C, "Organization of AFOAT-1," 13 September 1950, Headquarters United States Air Force (Air Staff), NARA NARA RG 341.10.6.

[309] Leslie M. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (New York: Da Capo Press, 1962), 140. The conflict over security in the Manhattan Project was between the basic principle of "free exchange of information" necessary to collaborative science and the military's security principles of "need to know" embodied in the practice of compartmentalization. In AFOAT-1, contact with outside entities, including other scientists, was strictly documented and regulated, as they were for military personnel, which will be discussed in detail shortly.

remained in the organization chart was in the form of a “science library.”[310] In light of other security policies it adopted, this linguistic distancing over the course of the first five years of its existence reflected the effective isolation of scientists working within AFOAT-1 from what the Air Force saw as the security threats posed by mainstream scientific interactions, including those of international scientific organizations and the AEC itself.[311] The service was able to pick and choose carefully who and what it interacted with so that such networking would be exclusively in the Air Force’s interest, a particularly salient issue given the tight security associated with all aspects of AFOAT-1’s work.

Taken together with the bulk of the other evidence, this implicit policy with regard to the role of science demonstrated the Air Force desired to ensure that its scientists would exclusively serve its needs. The service wanted to prevent the threat of science posed when it constituted an independent entity that might expose the Air Force’s most important intelligence source to the problem of scientific activism many in the military saw as an inconvenient outcome of the Manhattan Project.[312] Proof of that would come in the form of 1954 AEC hearing that stripped Robert Oppenheimer of his security clearance, but the evidence presented then clearly showed such concerns operated at the highest levels in the Air Force throughout this period.

Ironically, Truman’s announcement of the detection of the first Soviet test threw unwelcome light on the existence of the U.S. capability to detect nuclear testing. It took almost a year before the AFOAT-1 commander dealt with this security threat by issuing a memorandum on dealing with press inquiries.

> As was to be expected, the President’s announcement concerning the explosion of a Russian bomb generated a series of speculative articles by newspaperman and magazine writers concerning methods for the detection of atomic explosions…In preparing their articles the writers’ technique will be to probe the subject with

---

[310] Staff Memorandum 20-1C, “Organization of AFOAT-1,” 13 September 1950, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[311] AFOAT-1 scientists maintained an ongoing relationship with their British counterparts. See Michael S. Goodman, *Spying on the Nuclear Bear: Anglo-American Intelligence and the Soviet Bomb* (Stanford: Stanford University Press, 2007). Once the Geneva talks reached the level of an exchange of experts in the late 1950s, AFOAT-1 scientists began regularly interacting with those from the USSR. Ironically, they became far more familiar to their Russian counterparts than to the legislators and citizens of the United States.

[312] An outbreak of scientific activism in the summer of 1945 at the Met Lab in Chicago spread to other areas as targeting and other preparations to use the weapons the Manhattan Project produced were made. It resulted in an appeal by many scientists for Harry Truman to consider a demonstration attack instead of using it on a city at first, an incident that the military did not want to see repeated. For the military, such a situation represented an intolerable split chain of command, rather than the usual unitary chain of command typically found in the military.

> special attention paid to the reaction obtained…The newspaperman making the inquiry will be quick to detect any undue excitement aroused by his question.[313]

The memorandum went on to note the 1009th SWS "has no Public Relations officer. Therefore, all members of the press making any query concerning the AFOAT-1 mission will be requested to call the Public Relations Officer of the Air Force." Furthermore, the memorandum required anyone with knowledge of a press inquiry to immediately bring it to the attention of the commander of AFOAT-1. In effect, the unit would make no comment about its work, referring such requests to others to handle. The mere fact of a press inquiry suggested a breach of security, so required command attention in every case.

"Control of mission dissemination" by such policies was at the core of AFOAT-1's secrecy and received considerable attention both inside the organization and in necessary contacts with those outside of it. Official contacts that revealed the classified mission of the 1009th SWS to outside organizations – as well as any technique used by it – were strictly documented and limited, including with other government organizations and military units. Each contact outside the 1009th SWS required documentation on a Form 205-6 and was based on a strict "need to know" principle. Any such contact, except in an emergency, required prior approval of the commander, deputy commander or technical director. Internally, before any officer, enlisted service member, or civilian worker was granted the proper clearances, they received a documented intake security briefing. Once assigned to a field station, incoming personnel received another specific briefing based on the assignment; further security briefings to review existing and new restrictions occurred on a quarterly basis thereafter. Each was documented, including a reference in each briefing to the criminal penalties provided for violations of the Atomic Energy Act of 1946.[314] Service in AFOAT-1 required all personnel to take strict precautions against discovery of the unit's mission. Violations of these strict requirements could bring criminal charges.

Counterpoised against what the 1009th SWS was actually engaged in were a series of cover stories that could, when pressed, be used to deflect inquiries by the curious in legitimate contact with the unit. Those engaged in aerial sampling of fallout debris clouds were advised to

---

[313] 1009th Special Weapons Squadron Staff Memorandum 190-1, "Public Relations: Press Inquiries," 14 June 1950, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[314] 1009th Special Weapons Squadron Staff Memorandum 205-6, "Security: Control of Mission Dissemination," 24 March 1952 (supersedes SM 205-6, 5 January 1949), and Regulation 205-1, "Security: Safeguarding Classified Information," Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

indicate “This unit is conducting meteorological studies concerning the composition of the atmosphere.” Those operating the B/199 airborne gas sampler might reply “This instrumentation is used to measure cosmic rays to determine their effect on weather phenomenon.”[315] Personnel at seismic stations, if pressed, could explain “This instrumentation is employed in meteorological studies of the movement of storm centers.”[316] Even these vague and often logically confused cover stories were so sensitive they were not to be used, unless needed, because “the unclassified mission explanation should not be revealed unless it is absolutely necessary to furnish some unclassified explanation for the presence of the team at that location.”[317] Thus, even official cover stories were so sensitive that personnel assigned to AFOAT-1 were prevented from using them merely to deflect the idly curious.

Those with TOP SECRET clearances were still limited in what information they had access to or could convey, because of the dangers informing someone with too much “information of such a nature that general knowledge…might result in jeopardizing sensitive operations or sources of intelligence information.”[318]

At the conclusion of their service with the 1009th SWS, departing personnel received a “Security Termination Briefing” in which, among other things, they were reminded a final time of their obligation, certified under penalty of law, thereafter to “not in any manner reveal or divulge to any person any military information or restricted data of which I have gained knowledge during my tour of duty except as may hereafter be authorized.”[319] This meticulous expectation to conceal the mission of AFOAT-1/1009th SWS effectively amounted to an indefinite bar on discussion of anything about their assignments and missions unless prior command approval was granted. These warnings served to discourage attempts to document their service or construct a history of the organization outside of the little available in official sources. In the context of the apparent defections of Air Force personnel to North Korea, the Rosenberg case, and lingering “red scares” of the early 1950s, such precautions likely seemed more

---

[315] 1009th Special Weapons Squadron Regulation 205-1(and Appendix 9), “Security Classification Guide for Aerial Counting Units,” 17 March 1954, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[316] 1009th Special Weapons Squadron Regulation 205-1(Appendix 3), “Security Classification Guide for Seismic Units,” 30 April 1954, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[317] 1009th Special Weapons Squadron Regulation 205-5, “Security: Seismic Units,” 28 March 1952, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[318] 1009th Special Weapons Squadron Staff Memorandum 205-13, “Security: Clearances to Receive Certain Information,” 26 October 1954, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[319] 1009th Special Weapons Squadron Staff Regulation 55-15, “Operations: Team 157,” 9 June 1954, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

effective and justified then than they are regarded now. These, along with extended classification on the topic provided only a very limited historiography of nuclear intelligence until recently.[320] The unit was among the elite few Cold War era organizations able to obscure a substantial part of its history and operations as part of the U.S. intelligence community well into the twenty-first century.

Further concealment was provided in the course of such ordinary business as addressing mail. Although AFOAT-1/1009th SWS was initially housed in one of the wartime temporary buildings near 18th and G Streets NW in Washington DC, its several mailing addresses reflected a location in the Pentagon. The first was Room 4A-948, whose occupants apparently merely forwarded the mail addressed there to a fictitious "Special Weather Research Unit" – AFOAT-1. Other than double-enveloping mail, instructions for using these addresses made special note that:

> Particular precautions will be taken to insure that no connection is shown between field units and the 1009th SWS or AFOAT-1. Under no circumstances will the address shown…include any reference to either 1009th Special Weapons Squadron or AFOAT-1…Messages transmitted between these offices which show the connection between the field and/or AFOAT-1 and the 1009th Special Weapons Squadron will be classified at least SECRET.[321]

Below headquarters, AFOAT-1 was organized into field offices and field teams.[322] The field offices served as regional support centers for the field teams in their region. They provided laboratories for radiochemical analysis, centers for logistical and maintenance support, and

---

[320] See Appendix C. William M. Arkin, *Code Name: Deciphering U.S. Military Plans, Programs, and Operations in the 9/11 World* (Hanover, NH: Steerforth Press, 2005), 1-13, 15-16. While some details have changed, the classification sensitivity of AFOAT-1's mission suggests it would be treated as a special access program (SAP) if in existence today under the same circumstances. The early Cold War was a simpler time, with Secret and Top Secret the typical classifications used. Programs "above Top Secret" were treated more informally as extensions of specific "need to know" aspects of Top Secret. The documents and narratives referenced here support this approach as in use during the late 1940s and early 1950s; none of the redacted text appeared to be positioned so as to represent additional classification markings that would have been present if formally part of additional restrictions. In recent decades, large segments of AFTAC work is most likely covered under a group of specific SAP designations assigned to Joint Forces Command (because AFTAC activities are directed by the JCS) that apply to nuclear intelligence. In a world of internet-enabled leakers and ever-resourceful journalists, as well as disillusioned employees cognizant of official excess, the value of oaths of secrecy seems to be primarily the suppression of incentives to talk to the press in an effort to avoid unwelcome publicity by the U.S. government or one of its clients. Nonetheless, as Arkin notes, "most genuine secrets remain secret." Force of habit dies hard. Despite the clearance to allow AFOAT-1/1009th SWS veterans to discuss basic facts about their service in conjunction with AFTAC's fiftieth anniversary in 1997 with family and friends, what the author's father has said about it since would probably fit on one page here and be completely mundane, because as he pointed out, "they didn't tell two-stripers much."

[321] 1009th Special Weapons Squadron Letter 10-1, "Correspondence: Mailing Addresses," 25 September 1950, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[322] See Appendix E for table of field office and team/station numbers.

specialists in the various detection techniques in use who were available to analyze and troubleshoot problems encountered by field teams.

Field teams were located at field stations or detachments, designated by a three-digit number. The field team station number was sometimes given a suffix to designate the technique in use at a particular station. Teams located on military installations operated under cover provided by the host unit, with no one cognizant of their mission except on a strict need-to-know basis. Teams stationed in remote areas without a supporting unit to provide cover took particular care to avoid revealing the nature of their duties. Personal mail was received under the address of the unit they were attached to when the team was co-located at a supporting unit.[323] While the team number, when used without the technique letter prefix, was an unclassified short title, any connection between the team number and the mission was considered classified information.[324] Team commanders were responsible for taking comprehensive measures to ensure the communications and operations of their personnel "do not reveal the function of their activity nor its connection with the 1009th Special Weapons Squadron."[325] Initially, this compartmentalization even applied to other 1009th SWS units located at the same installation. Senior officers were responsible for placing:

> …such restrictions on the movement of 1009th SWS personnel between units at the site as are necessary to insure adequate compartmentalization of the operations, except when specifically authorized otherwise by this Headquarters."[326]

In phrasing that was more ambiguously confusing than helpful, prohibitions against dissemination of information beyond those working specifically on a team were eventually relaxed in 1953 for colleagues in certain areas:

> For purposes of security, it is essential that dissemination of the knowledge of the type of work in which field offices are engaged, the organizational connections thereof, and the type of material collected by the system be compartmentalized

---

[323] Overseas military mail is typically addressed to the unit of the addressee to ensure proper forwarding. The use of another unit's APO address thus avoided revealing signs of the presence of AFOAT-1.

[324] This tradition continues in AFTAC's *A Fifty Year Commemorative History of Long Range Detection: The Creation, Development, and Operation of the United States Atomic Energy detection System*, which contains a number of photographs of team operating locations captioned only with the team's number. While some locations are obvious, the author was only able to identify others after extensive research.

[325] 1009th Special Weapons Squadron Letter 5-1, "Publications: Directory of Addresses and Team Designations for 1009th Special Weapons Squadron Field Activities," 8 January 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[326] 1009th Special Weapons Squadron Regulation 205-7, "Security: Radiochemical Laboratories," 10 July 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

> and confined to those individuals whose official duties require such knowledge. (These provisions are not intended to preclude the dissemination of general knowledge which is not required in the execution of specific duties yet is of general information leading to an intelligent understanding of assigned duties).[327]

This phrasing replaced the earlier language implying individual members of a team could never discuss their roles with each other without high level authorization. Given the isolation of many teams, the repetitive and often monotonous work, and the paranoia of the era, it was likely thought best that more practical language should substitute to prevent misinterpretations of the earlier security procedure. It only made sense that other team members trained to perform similar tasks were available if illness or other circumstances left a team short-handed in the field given the tiny size of each unit, typically less than two dozen. This slight relaxation in security procedures recognized the impracticality of maintaining such airtight virtual walls or information "stovepipes" among limited numbers of personnel AFOAT-1 operated with at remote locations.

As a security technique to limit information available to a strict need-to-know principle, compartmentalization also imposed other burdens. Teams received only two pages of the unit directory, one with its own listing and the other, explicitly invoking the "need-to-know" principle, was limited to "a supplement of the directory with all other field team addresses necessary to function."[328] Beyond security regulations overseen by their commanders, personnel at these often remote locations were expected to apply self-censorship to their personal mail and in conversation with unauthorized persons. Personnel could discuss the name of the cover unit under which their team operated. If they made the mistake of mentioning being assigned to the 1009th SWS, they were to then indicate that they had seemingly transferred to their cover unit's station. If they wanted to comment on a temporary duty assignment or leave taken while overseas at some of the exotic locations where teams were stationed, it was allowed unless their commander specifically prohibited such a reference. However, they were forbidden to disclose even the vague statement they worked on "a classified project for the USAF." Any reference to their work in connection "with any phase of Atomic Energy" was prohibited. Likewise, they were not to reveal the locations or addresses of anyone else assigned to the 1009th SWS. Finally,

---

[327] 1009th Special Weapons Squadron Regulation 20-2, "Organization: Eastern Field Office," 1 January 1953 Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[328] 1009th Special Weapons Squadron Letter 5-1, "Publications: Directory of Addresses and Team Designations for 1009th Special Weapons Squadron Field Activities," 8 January 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

they could not reveal the "names of other units and agencies with whom the field activity has regular contacts in the performance of mission."[329] This might include a number of other units, from the local supporting base command up through the Central Intelligence Agency. This frequently involved the many Air Weather Service units upon which AFOAT-1 depended to gather samples on the daily synoptic weather missions that provided forecasting data.

Team assignments took personnel from frozen northern latitudes to the opposite extremes of the tropics, but it was people more than location that provided the most challenging difficulties in the private lives of those assigned to the unit overseas. Even with self- and command-censorship, security concerns imposed further restrictions on the whole range of human relationships, which varied depending on the culture and amenities of life available outside the detachment's perimeter. Many units required that all airmen without dependents reside in quarters on base. If such housing was not available, then they must be "quartered in respectable abodes which are not subject to foreign interests inimical to the security of the mission." Even "frequent visits to foreign national homes" potentially placed "the mission in jeopardy because they will be subject to questions concerning the classified portions of the project." Personnel could not even escape the boredom of being stationed far from family and friends without risking the results of a little too much fun on Saturday night.

> Instances of airmen exhibiting undue interest in foreign nationals or cases involving too frequent association with foreign nationals in public places such as restaurants, taverns, or places of ill repute which cause the OIC [officer in charge] to suspect a possible security compromise will be reported to this Headquarters.[330]

Enforcement of security requirements was not left solely to the team commander. The field offices conducted inspection visits to team sites, so outside evaluations of unit security practices were usually conducted quarterly, but no less than annually.[331] Interestingly, the last security instruction noted above seems to have been rescinded in an updated regulation issued on 28 August 1952. One can only speculate that prohibiting airmen from engaging in "happy hour" at

---

329 1009th Special Weapons Squadron Regulation 205-7, "Security: Radiochemical Laboratories," 10 July 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

330 1009th Special Weapons Squadron Regulation 205-5, "Security: Security Inspection Reports," 19 March 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

331 1009th Special Weapons Squadron Regulation 205-8, "Security: Marriage of 1009th SWS Personnel to Foreign Nationals," 1 October 1952, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6. AFOAT-1 personnel were not under the jurisdiction of the Air Force Inspector General. Instead, it had its own inspection arrangements where assigned personnel were given unrestricted access to specially-cleared investigator during field office inspection visits.

remote locations without the usual service clubs, in practice, led to too many conflicts at the team level, sapping morale more than boosting security.

Another issue that arose in a nearly all-male military force was marriage. Those at whom cupid loosed his arrow overseas faced a discouraging future when assigned to AFOAT-1, because of the potential security compromises such relationships generated. In 1952, the policy was ambiguously stated to be that "marriage to foreign nationals will be permitted if approved by the Theater Commander [and] will constitute the basis for denial of further access to classified material."[332] As the end of 1953 approached, a clarification indicated more definitively those assigned to the "1009th SWS who marry, even though permission has been granted, are subject to termination of security clearance and reassignment…"[333] One can only wonder how many romances ended somewhere between the forbidden "places of ill repute" and the nearly equally prohibited institution of marriage for those assigned to field teams.

Other problems caused by compartmentalization ranged from the simple to the complex, even if it was something as basic as sending communications by mail or radio. The "Weather Research Division" address at the Pentagon used as cover for AFOAT-1's actual address came into question after it was pointed out that it was intended to be changed every six months or whenever compromised. The issue was that having different addresses, depending on the classification of the message sent, caused a significant workload burden on communications networks in an era where most communication was handled by code clerks, typewriters, paper forms, and teletype, effectively doubling the time needed to send a particular message.

The realities teams faced in the field meant implementation of some security directives from headquarters ranged from difficult to impractical. By 1952, ten teams were already co-located and likely somewhat aware of what each other was doing. Inspections confirmed teams were often cognizant of the work of others, despite the extensive internal efforts to suppress this information. Eventually, it was concluded the security regulations should be updated so the addresses of other teams were simply considered secret and thus could be shared to facilitate the mission more easily than previously permitted by Top Secret classification.[334] In a very real

---

[332] 1009th Special Weapons Squadron Regulation 205-5, "Security: Security Inspection Reports," 19 March 1951, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[333] 1009th Special Weapons Squadron Regulation 205-8, "Security: Marriage of 1009th Special Weapons Squadron Personnel," 28 December 1953, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.
[334] 1009th Special Weapons Squadron, Inter-Office Memorandum, Chief, Personnel to Commander, AFOAT-1, 16 December 1952, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

sense, just as the utility of nuclear weapons was eventually limited by their fallout, these communication problems indicated that the security of the American nuclear intelligence effort was constrained as much by the limitations of secure communication technology as it was by strict enforcement of rules, regulations, and the law. These COMSEC issues resembled the relationship between the bomb and fallout, between the desired and the compromised, complicating accomplishment of the mission while imposing an unpredictable cost on it.

Other problems encountered reflected the growing realization nuclear war would bring unprecedented destruction in the Washington DC area. By 1953, AFOAT-1 established two alternate headquarters for itself and another alternate headquarters location for the 1009th SWS. This added to the problem of communication workload in support of this global intelligence network, because it required determination of whether each message should be produced in quadruplicate or not, in order to make copies of documents available at the alternative sites.[335]

Detection Techniques Beyond Fallout

Now that readers can more fully appreciate the stringency of security culture imposed throughout the ranks to protect AFOAT-1's mission and organization, it is time to explore sources and methods that produced intelligence data beyond the mainstay of atmospheric testing-era fallout sampling described earlier.[336] Fallout sampling was considered by those involved in collecting nuclear intelligence to be the gold standard for conclusive proof a nuclear explosion occurred.[337] The bomb debris analysts were so capable and thorough, they could reconstruct the weapon's design "down to what color it was painted."[338] The other "techniques" served two primary purposes. First, there were techniques providing the capability of what AFOAT-1 referred to as "instantaneous detection."[339] Second, there were techniques providing correlation and confirmation for both instantaneous and sampling techniques, as well as those used to

---

[335] 1009th Special Weapons Squadron Staff Memorandum 10-3A, "Correspondence: Preparation and Procedures," Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

[336] Also see Appendix A for basic information on isotopes useful for intelligence purposes and Appendix C for a summary of techniques other than fallout sampling and analysis.

[337] William B. Scott, "Sampling Missions Unveiled Nuclear Weapons Secrets," *Aviation Week and Space Technology*, 3 November 1997, 55. David F. O'Brien, AFTAC chief scientist, commenting on the loss of the unit's aerial collection capability due to budget cuts in 1997: "Almost all other techniques….aren't totally unique to a nuclear explosion. But, if you collect debris, there's nothing else that could produce that."

[338] William B. Scott, "USAF Nuclear Detectives Assume New Roles," *Aviation Week and Space Technology*, 3 November 1997, 53.

[339] 1009th Special Weapons Squadron Regulation 20-2, "Organization: Field Offices of the 1009th SWS," 4 November 1954, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6.

determine other information, such as the atmospheric loading of krypton-85 that revealed Soviet plutonium production.

It was important to detect each Soviet test reliably so that the pace and results of their weapons program could be accurately assessed. Instantaneous detection alerted the rest of the AEDS network to mobilize intensified surveillance in an effort to locate the resulting plumes, gather fallout samples and analyze recorded signals for additional data. The original way instantaneous detection was accomplished was via the Army Signal Corps acoustic listening posts, once it was clear what audio and sub-audio wavelength signals nuclear tests generated and where this network should listen. Developed for use in locating batteries of enemy artillery when they fired on the battlefield, the acoustic technique (designated the "I" or infrasonic technique by AFOAT-1) initially depended on an existing network of Army listening posts. This was supplemented beginning in 1953 by deployment of several more posts dedicated to serving the AEDS.[340] At its peak extent in 1969, it was in use at more than two dozen sites, mostly in a wide arc surrounding the Soviet Union, but also capable of providing the same information about Chinese and, eventually, other atmospheric tests not constrained by the 1963 Limited Test Ban Treaty (LTBT).[341] Although considered to be robust and fairly reliable, the I technique's capabilities could be affected by weather and atmospheric noise. Thus, it detected many nuclear explosions in the atmosphere, but also could miss others, leaving an unmet need for additional techniques to provide multiple corroborations to reliably detect the timing of tests.

Seismology offered the most mature and promising method of providing near-instantaneous detection of a nuclear explosion, yet it still required enough development work that it eventually became embroiled in significant controversy when called upon in 1958 to support enforcement of a global comprehensive test ban. The development of a continental test site in Nevada held several advantages for the use of seismology by AFOAT-1. The geology of the site was believed to resemble the Soviet Union's main test site at Semipalatinsk more than proposed U.S. test sites in the Pacific (although it was later discovered significant geologic differences

[340] Besides nuclear explosions, later manifestations of the "I" technique eventually detected a variety of sounds of scientific interest, such as meteors entering the atmosphere, eruption of volcanoes, and sounds created by earthquakes. Some historical data recorded during the Cold War was later declassified to provide it to scientists working on research that could benefit from the documentation it provided. While not exactly comparable to the still-withheld classified fallout data the CDC and NCI seek, releases like this do provide clear precedent to release sensitive historical intelligence data for important scientific research.

[341] Air Force Technical Applications Center. *A Fifty Year Commemorative History of Long Range Detection* (Patrick Air Force Base, FL: Headquarters AFTAC, 1997), 97-100.

existed between the Soviet test site and NTS.).[342] Its location also impeded the Soviet Union from using the same techniques as AFOAT-1 to study the U.S. nuclear program. The Pentagon's pressure on the AEC for a continental test site because of the Korean "war emergency" may have been as much about the need for an accessible site that would facilitate nuclear intelligence research and development and permit crew training while limiting the Soviet Union's ability to capture samples as it was about forcing the AEC to decide on testing at NTS.

The electromagnetic pulse (EMP) technique was used experimentally at least as early as SANDSTONE in 1948, but officially came online as part of the AEDS network in 1953. Its great advantage was its truly instantaneous detection, since it was based on radio waves traveling at the speed of light, rather than the orders of magnitude slower acoustic and seismic waves. EMP thus provided an initial alerting capability for AFOAT-1's other techniques, as well as opened the door to an important warfighting role for the unit. During the early Cold war, the first signals of a Russian attack would likely come from EMP from exploding weapons picked up by the AEDS, especially so in the years before the DEW (Distant Early Warning) Line's radars became operational in 1957 and the Ballistic Missile Early Warning System (BMEWS) achieved initial operational capability (IOC) in early 1960, making the unit's integration into the chain of command a vital link in whatever response was made to the threat of a "nuclear Pearl Harbor" that was the object of fearful obsession inside and outside the government during the 1950s.[343] The warfighting role of AFOAT-1/AFTAC was thus quite limited at first, but as instantaneous detection became more sophisticated, its role grew, although it has drawn less comment than virtually any other aspect of AFOAT-1/AFTAC operations, perhaps the most guarded of all its secrets.

The Construction of "Safe" Nuclear Testing

The Atomic Energy Commission bore ultimate responsibility for safely conducting testing, but responsibility for radiological safety to protect workers and the public, or rad-safe as it became known, was split between it and the military. The military task group commanders could also order waivers authorizing additional exposures to the mostly military personnel used

[342] Initial technical training in seismology took place at Lowry AFB at Denver, Colorado. Advanced training and research and development in seismology was supported by locations in Wyoming optimized to detect tests conducted at NTS.
[343] The Distant Early Warning (DEW) Line protected against air-breathing bombers attacking from the Soviet Union, while BMEWS stood guard against missile attacks across the North Pole.

to conduct these operations.[344] The military's control of these resources allowed it to seamlessly hand-off tracking of fallout plumes for test shots between close-in "cloud trackers" who handled test diagnostic sampling done for the AEC and the secret units testing and training for long range detection operations outside a roughly 200-mile circle around NTS once fallout moved past it.[345]

The AEC's primary concern in testing was gathering weapon design data while minimizing radiation exposures for those involved. On the other hand, the military wanted to test both equipment and personnel under conditions that resembled as closely as possible the conditions of actual nuclear war. Even though it ostensibly observed limitations on human exposures, officers managing military involvement in the testing process did so amid constant command pressure to not let such considerations unduly impede its mission. The exposure of large numbers of military personnel was seen by the AEC as clumsy, creating an unnecessary hazard for those involved. After the 1951 GREENHOUSE test series in the Pacific, the military task group commander generated a report which left one AEC rad-safe expert "feeling that the report favors liberally dosing the military personnel with radiation at future operations, for the purpose of eliminating undue timidity..."[346] Although governed by standards based on the same assumptions about the relative benign nature of fallout as the AEC's, the military nonetheless constantly pushed for further exceptions and relaxations to these exposure standards.

The process of marketing nuclear weapons as controllable guarantors of national security included the involvement of many troops as non-volunteer observers. The peacetime draft was also in effect, so there was always a large pool of incoming citizen-soldiers to enjoy the dubious privilege of witnessing a test shot. However, the movement of those exposed through official policy into and out of military service aggravated the military's problem of multiple fallout narratives in circulation once these citizen-soldiers left the information-controlled military for civilian life. Despite security restrictions, these military test audiences inevitably communicated with civilian Americans. It remains unclear whether this benefited or ultimately worked against efforts to shape fallout's image as benign. The potential for positively communicating policy through survival despite exposure to the awesome nature of nuclear weapons was balanced

---

[344] Hacker, *Elements of Controversy*, 37-8.

[345] Ibid, 101. The author believes that "beyond 200 miles" is part of the operative definition of Long Range Detection (LRD) of cloud sampling, as distinguished from cloud tracking which is directly associated with testing. It should be noted that Eisenbud claims, in variance to Hacker, that HASL had responsibility out to 500 miles. Taylor's *History of Air Force Atomic Cloud Sampling* did not provide a definitive answer to this.

[346] Ibid, 59.

against the wide range of ambivalent and even most certainly a number of negative experiences many had with nuclear weapons during their service. The organization of groups such as the National Association of Atomic Veterans (NAAV) suggested security culture could generally preserve official secrets, but not prevent airing of the intensely personal reactions of many service members to their experiences with nuclear weapons.[347]

Those exposed to the raw fury of nuclear blasts were frequently given brief surveys and psychological evaluations in connection with their participation in the tests. The process at times included ordering troops to dig in closer to ground zero than AEC standards would allow them to remain at the time of the blast. These fighting positions were evacuated just before the shot; troops returned to these forward locations afterwards to see "how minor the risks of staying in place might have been."[348] In a sense, "training" of this sort reinforced the idea that the unseen was thus unimportant, a key component in official elisions of fallout. With the large numbers of draftees, informed consent under those circumstances would have been problematic, even if it had been a goal. In the event of nuclear war, there would be no volunteers anyway, as everyone in the military would be a participant at that point, whatever their personal comfort level with radiation or draft versus volunteer status. The reactions of American civilians as strategic targets for enemy forces was also of great concern to the government, which resulted in funding of academic work in disaster studies to study their response.[349] Thus, the concept of informed

[347] The term "atomic veteran" is an official U.S. government classification for those whose military service exposed them to ionizing radiation, as well as a term in more general use by the public for those exposed to Cold War radiation. The author is an Associate Life Member of the NAAV. Originally, the organization took non-veterans as members based on several criteria, two which applied here (because of personal exposure to fallout during atmospheric testing and as a dependent of a qualified atomic veteran.) Civilians living during the time of atmospheric testing were originally considered "veterans" of surviving fallout by the NAAV as a matter or political assertion by all those affected, since it was a unifying threat faced by both military veterans and civilians alive at the time. More specifically, because my father worked with or was exposed to ironizing radiation in the course of his service I was eligible to be a member as his dependent. For political, tax, and full official recognition by the Department of Veteran Affairs, about a decade ago the NAAV converted to an officially recognized veterans' service organization. Those non-civilian Associate members who were not Associate Life members were dropped from the rolls when their current membership expired; new Associate memberships are not accepted as their membership in the same organization would disqualify it as a veteran's organization. Existing Life Associate members were grandfathered in; although few in number, they may possibly form the core of a future non-veteran advocacy organization when the last atomic veteran dies and the benefits of recognition provided by the current veteran's service organization model no longer apply.

[348] Hacker, *Elements of Controversy*, 67-8.

[349] Michael Amrine, "Too Much Secrecy Can Hurt," Air Force, Vol. 36. No. 11 (November 1953), 41-42, 45. In discussing secrecy surrounding the threat posed by nuclear war, Amrine implicitly invoked fallout as several of his sources similarly intuited was at the root of the lack of motivation in civil defense activities. Amrine likewise cited Rensis Likert, a psychologist working in the field of disaster studies who was a former member o the United States Strategic Bombing Survey about what effect a better understanding of the threat of fallout might have on Americans

consent as it is now practiced was a concept that the AEC – and even more the military – treated as foreign to the fundamental concerns of secrecy, military life, and the threat posed by nuclear weapons against millions of civilians in the 1950s.

A major objective of exposing troops to these nuclear events was to gain insight into the problems of troop control, discipline, and morale likely to occur in actual nuclear war. Military leaders argued there was no substitute for using the real thing in training because "the realism engendered by coming face-to-face with an actual nuclear detonation adds a great deal to the benefits derived…"[350] While science had its share of the radiation-reckless, from the Curies to Louis Slotin to Edward Teller, in seeking to banish fear among military personnel the military as an institution consistently chose to banish reasonable caution about the dangers of radiation exposure in favor of tidy reassurances.[351] If it was not official policy, the evidence suggested exposure to radiation, whether intellectually in training or in reality by participation in maneuvers at tests, official portrayal of fallout exposure as easily managed and minimally threatening was an example of "in effect" policy. In-effect, military policy sought to avoid giving credence to the dangers of fallout in the belief such discussions undermined the fundamental utility of nuclear weapons by emphasizing extraconventional effects of little consequence. Official narratives that depicted manageable and useful nuclear power were a form of "talking cure" for nuclear fear, a ubiquitous focus of psychological work during the Freudian Fifties.

Division of Fallout Tracking Responsibility

The breakdown in responsibilities for sampling between the AEC and the AFOAT-1 for RANGER illustrated how military compartmentalization prevented a complete set of accurate data from fallout samples reaching those in the AEC with the responsibility for radiation safety. The *History of Air Force Atomic Cloud Sampling* described the delineation of responsibilities:

---

if they only learned about it the hard way. Likert noted the reactions of Germans and Japanese to Allied bombing did not bring anger toward their attackers. Rather, "It was always directed against *their own governments* [emphasis in original], not against the enemy…who had encouraged them to believe defense measures would be perfect."

350 Miller, *Under the Cloud*, 214. Miller quoted a 1955 Marine report on exercises held at Exercise DESERT ROCK IV conducted at the Nevada Test Site.

351 Marie Curie who, along with her husband Pierre, made many of the early discoveries about radiation and shared a Nobel Prize in Physics, then was awarded the Nobel Prize in chemistry after his death, died from the effects of radiation poisoning after seeing many of her co-workers similarly pass away. Louis Slotin was a researcher at Los Alamos when he performed the final test of the core scheduled to become the ABLE shot at CROSSROADS to verify it would go critical. The so-called "demon core" that previously irradiated Harry Daghlian exposed Slotin to a massive dose of radiation during a brief critical excursion; Slotin died nine days later. See Lillian Hoddeson, et al, *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945* (Cambridge: Cambridge University Press, 1993), 340-342. Edward Teller's enthusiasm for thermonuclear weapons was matched by his dismissal of significant concern about their potential to create massive fallout.

> …the cloud tracking aircraft were a [rad-safe] requirement established by the Atomic Energy Commission. The cloud samplers, however, were for the Air Force atomic energy detection system [AEDS].[352]

Thus, once fallout drifted off the test site, the Air Force cloud-trackers handling close-in sampling would appraise AFOAT-1 of the direction of the plume. In effect, this limited AEC sampling to the contents of fallout specifically required for weapons development. Despite this source and Hacker's definitive work on the AEC's efforts to deal with radiation safety in testing, it was unclear who, if anyone, shared responsibility for notifications when off-site dosage rates from fallout exceeded the relatively liberal exposure standards of that era.

In fact, the AEC made "no plans for distant monitoring," leaving it up to Kodak to complain (just as it did in 1945 after TRINITY) when fallout again affected its film manufacturing. These complaints about the threat to property presented by fallout, expressed through the National Association of Photographic Manufacturers, were what actually led the AEC to establish an off-site monitoring network, in order to protect the AEC from legal action by giving warning to film manufacturers when fallout from testing might threaten their manufacturing operations.[353] The director of the AEC's Health and Safety Laboratory (HASL), Merrill Eisenbud stated flatly that "HASL would not have been involved in fallout monitoring but for…[Kodak's actions]"[354] The hasty reaction by the AEC in setting up a monitoring system operated by HASL due to these complaints stood in stark contrast to the government's hardening, generally dismissive attitude toward public and scientific perceptions that fallout represented a risk, which continued throughout the 1950s. While it was true damage to film by fallout was easily demonstrable and the long-term health effects on humans somewhat speculative and difficult to document at the time, requiring a significant commitment of scientific resources to resolve, comparison of the paradoxical reactions of a lack of caution about human health and the quick reaction based on damage to property was an ironic comment on the safety priorities of the AEC. The great deference shown Kodak's concerns also threw light on the

---

[352] Taylor, *History of Air Force Atomic Cloud Sampling*, 30. Generally, cloud trackers followed the resulting test plume out to 200 miles from ground zero to obtain diagnostic samples. Beyond 200 miles was the purview of AFOAT-1 and its intelligence mission. Test plumes from NTS provided ideal training and research and development opportunities.

[353] Hacker, *Elements of Controversy*, 51, 67.

[354] Merrill Eisenbud, "Monitoring Distant Fallout: The Role of the Atomic Energy Commission Health and Safety Laboratory During the Pacific Tests, With Special Attention to the Events Following Bravo," *Health Physics*. No. 73 (1997), 21. Eisenbud noted Kodak began setting up its own radiation monitors after TRINITY.

government's indifference to providing the resources needed to study the risks of low-level human radiation exposure to fallout.

The highest exposure limits of all applied to the crews of sampling planes in use by the military in place of the troublesome drones used at SANDSTONE, thanks to Major Fackler's "accidental" cloud penetration there. The sampler pilots were all volunteers (it is uncertain if this applied to other crewmembers), although it was questionable in most cases whether any volunteers could be considered fully-informed test subjects in the sense that this term is now used. In the first test series conducted at the newly opened Nevada Test Site (NTS), the 1951 RANGER series, the Air Force invoked the Korean emergency yet again, this time to justify using manned aircraft rather than drones, stating its decision to use manned aircraft was because "there was no time to organize drone samplers" on the thirty-day notice the Air Force received before the beginning of the test series. Apparently, based on the previous "accidental" penetration of the SANDSTONE cloud by Fackler and his crew, in the three years since SANDSTONE the Air Force only planned to use manned samplers anyway at RANGER, not drones. Hacker reported that drones were still used at RANGER,[355] but this was contradicted in the source he cited.[356] Thus the first test series at NTS, RANGER, not only increased civilian exposures to radiation, because of its location in the continental United States but it also marked the beginning of a calculated increase in the exposure of the military personnel involved. This trend was driven by the military's desire to project the image of controllable, nuclear weapons with military utility on the battlefield. The issue was not so much addressing fallout, per se, but creating an atmosphere where nuclear weapons could be seen as creators of national security, rather than as a threat to public health and one's personal security.

Developing a Global Network

AFOAT-1 continued development work during 1951 on its LRD networks in a very busy year for testing, which included three test series: RANGER at NTS during January and February 1951; the GREENHOUSE test series during May and June in the Pacific; and a return to NTS in October and November 1951 for BUSTER-JANGLE. Even though sufficient justification for the original plans for the LRD system were fulfilled by its detection of Joe-1, accurate detection of Russian weapons testing presented challenges beyond those explored at GREEN RUN. The need

[355] Hacker, *Elements of Controversy*, 66.
[356] Taylor, *History of Air Force Atomic Cloud Sampling*, 30.

for system improvements became apparent as operational factors raised new issues requiring research and development: this work depended on using American test shots as a means to evaluate and calibrate new and existing LRD techniques.

Ironically, among the first problems faced was the fact that fallout from AEC testing interfered with collection of Soviet fallout for intelligence purposes, leading AFOAT-1 to complain "radiological contamination of the atmosphere during the Nevada tests [had] temporarily impaired long range detection capabilities based on the analysis of bomb debris."[357] The review panel recommended the AEC plan future U.S. tests so they did not interfere with LRD capabilities. This seemed to imply the AEC gained some access to intelligence information indicating the timing of potential Soviet testing, just as the AFOAT-1 seemed to have anticipated Joe-1, again suggesting the use of cuing provided by the CIA or communications intercepts. Most likely, it was testing at the higher latitude of Nevada which caused most interference with AFOAT-1's intelligence work. The near-Equator location of the Pacific Proving Grounds likely minimized the interference fallout from testing there caused to intelligence work, at least until the testing of high-yield designs began in late 1952.

The Russians unwittingly assisted the situation by testing relatively few weapons before 1954, making the radioactive signature of the fallout from each one distinct. Fortuitously (or perhaps not), the next two Soviet tests, Joe-2 (32 kilotons, 24 September 1951) followed by Joe-3 (42 kilotons, 18 October 1951), occurred just before the next U.S. test series, BUSTER-JANGLE, commenced in Nevada with the fizzle of BUSTER ABLE (<1 pound, 22 October 1951). The second Soviet test, Joe-2, was especially important to evaluating the improved effectiveness of the AEDS. It was the first Soviet test sonically detected on its initial signal, almost immediately determining the location of the blast, which aided in vectoring Air Weather Service WB-29s quickly in the direction of the resulting debris plume. Laboratory analysis by AFOAT-1 confirmed there was no thermonuclear reaction involved in a device composed of plutonium. Some aspects of AFOAT-1's analysis capabilities were still under development, however. A 3 October 1951 memorandum on the findings indicated that improvement in the following areas was possible: determination of the magnitudes and efficiency of the explosion;

[357] Memo from Charles P. Boner, Chairman, Joint Panel on IO-7, U.S. Department of Defense Research and Development Board to Chairmen, RDB Committees on Atomic Energy and Geophysics and Geography, "Detection of DOD Program for Long Range Detection of Atomic Operations", 1 July 1951, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB7/ae2-1.htm.

determination of the upper percentage limit of uranium-235 involved in an explosion in concert with the plutonium; and estimates of the contribution of any potential thermonuclear reaction in an explosion.[358] Confirming the last capability was a direct result of information obtained during the U.S. GREENHOUSE test series. The memo also took note Robert Oppenheimer remained within this compartment of information, a situation soon to change.[359]

With the international crisis surrounding Korea peaking, the American push to develop a thermonuclear fusion weapon or "superbomb" depended on several series of tests that began in 1951, starting with GREENHOUSE in April and May. This test series began with two shots as proof tests of the Mark 5 (GREENHOUSE EASY – 47 kilotons, 20 April 1951) and Mark 6 (GREENHOUSE DOG – 81 kilotons, 7 April 1951) weapons then entering the stockpile. The improved designs for the Strategic Air Command were intended to arm the pending rapid expansion of its bomber fleet with B-47 and B-52 aircraft. The Mark 5 weapon proof test also had another purpose – the design would serve as the primary, or fission, stage of the upcoming IVY MIKE thermonuclear proof-of-concept test planned for late 1952. GREENHOUSE GEORGE (225 kilotons, 8 May 1951) was an experimental device. It provided data on the process of radiation implosion that contributed to the refinement of the Teller-Ulam thermonuclear weapon design. GREENHOUSE ITEM (46 kilotons, 25 May 1951) tested the principle of the "boosted" nuclear weapon, which significantly increases the yield of a fission weapon by injecting tritium into the core of the weapon, an efficiency feature used in nearly all current nuclear weapons.[360] For these tests, sampling aircraft were a key component of evaluating the new designs, since "radiological sampling provided one of the most important

---

[358] Memorandum from Athelstan Spilhaus, Acting Chairman, Panel on IO-7 to Chief, AFOAT/1, "Review of Dogface Data," 3 October 1951, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB7/ae3-1.htm. Note that memo from the Panel on IO-7 was on a Department of Defense Research and Development Board letterhead.
[359] This document suggested a conflict between it and a finding by Patricia J. McMillan in her *The Ruin of J. Robert Oppenheimer and the Birth of the Modern Arms Race* (New York: Viking, 2005), 152. Tracking this down while writing the draft of this chapter quite unexpectedly led to Chapter Three's examination of what led to the 1954 AEC hearing that permanently stripped Oppenheimer of his clearance. McMillan pointed out Robert Oppenheimer's "Air Force clearance" was suspended as of May 1951. The IO-7 memo may have been simply an oversight connected to the Air Force's secretive withdrawal of his clearance, which had only limited circulation because of the sensitivity of this matter; Oppenheimer did not work on any panel examining data on Soviet tests other than for Joe-1. The IO-7 panel consultants were likely not cleared for cognizance about the suspension of Oppenheimer's clearance, which may have led to the assumption he would work subsequent Soviet test shots. Chapter Two argues it only applied to nuclear intelligence; notice of it was very limited, likely verbal notification of those with a need to know only.
[360] Carey Sublette, "The High Energy Weapons Archive: Operation Greenhouse," http://nuketesting.enviroweb.org/hew/Usa/Tests/Grnhouse.html . Also see Rhodes, *Dark Sun*, 379-498, for a more detailed history of U.S. thermonuclear weapons development.

methods of measuring weapon efficiency."[361] GREENHOUSE, by virtue of the higher expected yields, reverted to large-scale use of drone aircraft. The results were decidedly mixed, with drones crashing or becoming uncontrollable on every shot.[362] These failures added further impetus to the Air Force's already strong desire to study more closely the interaction of nuclear weapons and human radiation exposures during operations by using manned samplers.

In-Your-Face Fallout

The Air Force and the AEC decided future sampling missions during testing would involve manned aircraft. In the process, the delineation between Long Range Detection and close-in sampling became more distinct. The AEC's Los Alamos Laboratory was responsible for the equipment used by the manned samplers which included small, short range jet aircraft for the first time, with installations on the B-29s used for long range samplers made to meet "AFOAT-1 requirements."[363] In this fashion, AFOAT-1 captured a consistent record of the "fractionation" of the bomb debris from detonation onward.[364] Close coordination between the AEC and AFOAT-1 continued despite extensive security measures, with AFOAT-1 crews working alongside crews from the 4925th Test Group (Atomic), the Air Force unit responsible for air support for test operations. Samples for both AFOAT-1 and the AEC came off the same close-in sampling aircraft at the next test series, BUSTER-JANGLE, held at the Nevada Test Site in October and November 1951.[365] This series included two shots, JANGLE SUGAR (surface burst – 1.25 kilotons, 19 November 1951) and JANGLE UNCLE (sub-surface burst – 1.25 kilotons, 29 November 1951), which offered opportunities to calibrate the newly operational seismic portion of the Atomic Energy Detection System. With these calibration shots completed, the AEDS was in place as a basic, operational global long range detection network by the end of 1951 as originally scheduled. The need to meet this deadline was a likely reason the military rejected a

[361] Taylor, *History of Air Force Atomic Cloud Sampling*, 34.
[362] Ibid, 36-37.
[363] Ibid, 39.
[364] Fractionation is defined as enrichment of one isotope relative to another in a chemical or physical process, but it has several different usages in nuclear medicine and conventional chemistry that do not exactly parallel its use in fallout sampling. In this early Cold War context, it referred to the study of this problem in terms of how it described the decay of fallout in samples from the plumes generated by nuclear explosions. In reference to fallout, fractionation referred to how the mix of isotopes changed as a sample decayed following its creation at the moment of detonation, a feature that provided considerable information about the device, its design, and its efficiency.
[365] Carey Sublette, "The High Energy Weapons Archive: Operation Tumbler-Snapper," http://nuketesting.enviroweb.org/hew/Usa/Tests/Tumblers.html (8 March 2003).

proposal suggested by the AEC to postpone these two particular weapons effects tests until spring 1952.

The two JANGLE shots caused considerable concern to the AEC about "the level of radioactivity that the outside populations should be allowed to take" because shots closely coupled to or shallowly buried in the ground create extensive fallout, even with the low yields of these two shots. A discussion of raising the allowed doses to the public led to the planning of emergency evacuations for civilians downwind from the test site, if needed. In addition to helping calibrate the AEDS, JANGLE was intended as a "dirty" shot under conditions designed to provide data Rand Corporation used to produce its first fallout models.[366] Intense fallout exceeding AEC limits occurred within NTS, but was not observed off-site. The low yield of the JANGLE shots (1.25 kilotons) contributed to the relatively limited fallout detected off-site from these "dirty" shots, but their limited dispersion depended just as much on favorable winds.[367] The comparison between the B-29s and the T-33 jet samplers favored the jets, since they exposed only one or two crew members to radiation and returned the filters for evaluation more quickly than the B-29s, resulting in more complete, "stronger" samples of short-lived isotopes. However, the jets were hampered by a relatively short range, a problem which soon recurred with fatal results at IVY MIKE in late 1952.[368]

Indicative of the official attitude of the Air Force was a filmed example of a crew briefing that minimized concerns about the threat of radiation for a WB-29 sampling aircrew on the BUSTER CHARLIE shot (14 kilotons, 30 October 1951). The rad-safe officer on the mission was also the special equipment operator (SEO), tasked with directing the aircraft so that it could get optimal samples of the radioactive cloud. As with Fackler's unscheduled penetration at SANDSTONE, the conflict of interest between mission accomplishment and safety continued; the same person chose when it was "hot" enough to sample and when it was too "hot" to stay in the debris plume, indicating the aircraft should immediately leave.

The SEO's statement to his crew summed up the Air Force's "in effect" attitude to the risks posed by fallout. The Air Force's documentation of this sort of mission both portrayed what

---

[366] RAND, "Summary Report of RAND Work on the Armed Forces Special Weapons Project Fallout Project," (Santa Monica, CA: RAND Corporation, 1960) http://handle.dtic.mil/100.2/AD337920, 7.
[367] Hacker, *Elements of Controversy*, 66-72.
[368] Taylor, *History of Air Force Atomic Cloud Sampling*, 39.

the service believed was the controllable and innocuous nature of radioactive fallout, as well as expectations for the crew's performance. Emphasizing the mission's importance, the SEO stated:

> We are going to prove to everyone who has to do it that they can fly in this stuff and remain in this stuff as long as they observe a few safety precautions. You've all been briefed on the amount of radiation you can get and still be on the safe side. I'd like to assure you will never get enough radiation on the inside of this aircraft to give a thought to the consequences.

Despite the commander's clearly stated nonchalance about fallout exposure, he also advised the crew, on exiting the aircraft after the mission, "to try not to touch the outside of the aircraft and get over to the rad-safe center."[369] While the fuselage did give some protection, radiation did not just disappear, as the military often portrayed, "into the stratosphere."[370]

Military training films depicted a continual emphasis of how little danger radiation was to military operations. If the military could operate in close proximity to nuclear explosions at NTS, civilians outside NTS boundaries, who were – hopefully – much farther away from what were seen by the military as the minor dangers of nuclear weapons, should have even less concern about fallout. Films of military operations around nuclear explosions from this era typically depicted quick reentries to the area of the nuclear blasts, as would be required to exploit the tactical advantage use of such weapons brought to the battlefield.[371] After all, there was little point in taking territory one could not occupy to defend if the weapon of victory made it uninhabitable. Propaganda in the guise of training films clearly illustrated a hardening, far-too-optimistic military attitude that found it difficult to later concede the existence of radiation hazards accompanying atmospheric testing or potential battlefield use of nuclear weapons. While ordinary citizens did not receive a "pep talk" like the sampler crew in the film, they shared the same atmosphere. Americans were nonetheless as assuredly along for the ride as the airmen.

A Newly Steep Learning Curve of Sampling's Conventional and Radioactive Perils

Shortening exposure times by using high performance jets as samplers instead of lumbering converted bombers seemed like a relatively easy fix when first used in the context of

[369] Department of Defense, *Military Participation on Buster-Jangle*. 16mm, 1:17:00. Lookout Mountain Laboratory, Hollywood, CA, 1952.

[370] Department of Defense, *Staff Film Report of the Armed Forces #177*. 16mm, 27:51. Army Signal Corps, 1951.

[371] Two simple examples come to mind. First, such a weapon could be used to break an enemy attack, but this would require that the frontlines be reoccupied to consolidate the gain. Alternatively, a nuclear land mine could be emplaced, then detonated; this again would have required American troops to enter the zone or adjacent areas in order to accomplish more than a limited disruption of an enemy advance. One advantage was that use of such methods in Germany would more than likely send the fallout east on the prevailing winds, at best a Faustian bargain.

fission weapons. Their application to sampling thermonuclear shots proved more problematic, in large part because of the sheer scale of these effects, an issue made clear in the first thermonuclear test, the IVY MIKE device (10.4 megatons, 1 November 1952). The 561st Fighter Squadron was assigned to the sampling mission; it included pilot Kelsey Wynns and his compatriots, typical highly skilled fighter pilots of the early 1950s, part of a hardy group facing death on a daily basis simply flying the Air Force's primitive first-generation jet aircraft.[372] Most likely having seen the sampler crew training film made at BUSTER CHARLIE as part of their indoctrination, sampler pilots were described by one AEC rad-safe expert as seeming "to feel that they can go ahead and get higher exposures if they wish."[373] Despite the professional bravado and personal courage the Air Force counted on to complete these hazardous missions, sampler pilots were not a reckless or foolhardy group. For instance, Wynns took pains to persuade one of his fellow pilots, Jimmy P. Robinson, to sign up for low-cost military life insurance to protect his family.[374] Relatively better informed about the risks they were taking than most service members involved in nuclear testing, these pilots – like most of those involved in test operations – volunteered under questionable protocols of consent in comparison to current standards. However, their sense that they willingly accepted what they knew to be a dangerous mission probably accounted for the fact that relatively few of those directly involved in handling radioactive fallout, including those who served in AFOAT-1/AFTAC, subsequently joined advocacy organizations such as the National Association of Atomic Veterans. Comfortable with risk in general, they saw fallout as something that might stir fear in others, but was virtually written into their job description to ignore as just one more danger.

Due to the need to operate from an uncontaminated base the samplers for IVY were stationed on Kwajalein, over 300 miles away from ground zero on Eniwetok; it was a lengthy flight for the relatively "short-legged" fighters. Even at that distance, Wynns, who commanded the second flight of four samplers, felt the concussion of the 10.4 megaton blast from IVY MIKE's first full-scale test of the Teller-Ulam configuration while awaiting take off. Things quickly began to go wrong. Wynns ordered one of his wingmen to abort his mission after a failed refueling attempt en route. The intense electromagnetic pulse (EMP) from MIKE caused havoc

[372] Kelsey Wynns, manuscript (provided by Wynn's wife with permission to cite from it in 2003).
[373] Hacker, *Elements of Controversy*, 66.
[374] Wynns, 12. The Wynns manuscript is the primary source of this account of sampler operations at IVY MIKE.

with the flight control plan by shutting down or making useless radios and homing beacons needed for navigation by the samplers and other test aircraft.[375]

Captain Robinson, in the first flight of samplers, encountered intense radiation on entering the cloud at 45,000 feet, then suffered problems with his autopilot, possibly due to EMP's effects on its tube-era electronics, resulting in the aircraft spinning out of control when he tried to turn back. Successful recovery from the spin left him adrift inside the cloud at 20,000 feet, but the control aircraft's radar also was disabled by EMP and could not direct him to safety. Robinson eventually flew clear and, low on fuel, attempted an emergency landing on Eniwetok instead of returning to Kwajalein. Unfortunately, the sampler's jet engine flamed out from lack of fuel just short of the runway and Robinson was killed as his F-84 crashed into the ocean.[376]

Comforted only by the fact he convinced Robinson to sign up for life insurance, flying in the second group of samplers at 46,000 feet Wynns saw the massive cloud from MIKE towering before his aircraft, possibly as much as another 100,000 feet above his altitude. The radiation detector in the cockpit began picking up readings from the blast 120 miles away. Wynns attempted to climb higher, but his now-empty fuel drop tank would not jettison, holding him at a lower altitude while increasing the rate of his jet's fuel consumption as he led his remaining two wingmen into the roiling mushroom. The stem of the cloud was 130 miles across as he flew through its center. Emerging from the other side, he realized he had enough fuel to reach his refueling tankers, but only if he turned and flew directly back through the cloud again, instead of circling around it as originally planned to limit exposure of the samplers. Even then, it was a near thing as he had only ten minutes worth of fuel upon contact with the waiting tankers on the far side. Wynns landed with just enough fuel to make one missed approach landing.

The samplers taxied to a remote part of the airstrip. The pilots were plucked from their aircraft with cranes so flightline personnel would not come into contact with the contaminated exterior of the planes. The filters were pulled from the sampling pods, the pilots stripped and washed multiple times before they were able to pass muster with rad-safe personnel who scanned their bodies with radiation counters. After the samples were packed in lead casks, Wynns was armed with a .45 caliber pistol to escort them to the laboratory at Kirtland AFB, New Mexico

[375] Wynns, 10-11. Transistors had yet to be invented in 1952, but tube-design electronic devices were later considered superior in resisting the effects of EMP to those driven by transistors. However, close proximity to a multi-megaton shot likely caused EMP interference with tube-design electronics anyway.
[376] "USAF Report of Major Aircraft Accident, F-84G, Eniwetok," 1-4, http://www.aracnet.com/~pdxavets/robinso1.htm.

and seated aboard a C-54 transport for the long flight there.[377] Close-in samples like those returned by Wynns and his fellow pilots provided vital diagnostic info on the weapon designs, data often read from short-lived isotopes that quickly decayed, so speed in getting the samples to the AEC's laboratory was a priority.

Wynns learned later his exposure at IVY MIKE totaled 105.5 roentgens, with his wingmen receiving similar doses, because of the double pass through the cloud. He related that both of his wingmen were dead within two years, with everyone else involved as sampling pilots at MIKE succumbing before 1960, except him, although he did not list causes of death.[378] Advised to avoid fathering any more children, Wynns and his wife were blessed with another daughter after his exposure. The AEC regularly tracked the health of Wynns and his daughter as part of a long-term study conducted of those with the highest exposures acquired during testing. Lt. Col. Wynns died in 1999.[379] The long-term study of the Wynns' health, performed because of his known high exposure to radiation, appears to be one of the few conducted on service members by the AEC that commenced directly following their exposure.

"New Look" – Same Old Fallout

On the civilian side, nuclear weapons policy was forged in the White House. IVY MIKE's proof of basic thermonuclear designs principles took place on the cusp of the 1952 presidential election, delivering to the incoming president a powerful new weapon that simultaneously empowered and constrained national security strategy. Harry Truman extended his personal diffidence about discussing such matters through his order of silence in regard to the controversy sparked by the GAC's advice to not hastily pursue thermonuclear weapons. This forced an ominous public silence about fallout on AEC scientists, including J. Robert Oppenheimer, following Truman's decision after Joe-1 to ignore the AEC's recommendations.[380]

---

[377] Wynns, 12-16.

[378] Wynns clearly implies that radiation was responsible for these deaths, although he does not specifically address the causes. It should be noted that flying jet aircraft was a hazardous occupation in itself in the 1950s.

[379] Ibid, 17-18. Neither father nor daughter suffered from any health problem directly attributable to his radiation exposure. Unlike many in his early Cold War fighter pilot cohort, Wynns lived to a typical life expectancy and passed away from natural causes per conversation with his wife.

[380] J. Robert Oppenheimer, Chair, "The GAC Report of October 30, 1949," United States Atomic Energy Commission, General Advisory Committee. Also known as "General Advisory Committee's Majority and Minority Reports on Building the H-Bomb," http://www.pbs.org/wgbh/amex/bomb/filmmore/reference/primary/extractsofgeneral.html. The General Advisory Committee's three-part statement of advice on reactions by the United States in light of Joe-1's confirmation of Soviet nuclear capability was declassified in 1974. "The General Advisory Committee has considered at great length the question of whether to pursue with high priority the development of the super bomb. No member of the

Following the 1952 election, the presidency moved into the hands of Dwight D. Eisenhower, whose military background and fiscal conservatism prompted him to order his newly-appointed Chiefs of Staff to take the first steps in what became known as Ike's "New Look" defense policy.[381] The New Look planned national security fiscal economies based a shift in emphasis to nuclear weapons. The hope was nuclear weapons would prove a less costly solution to deterring the numerically superior Soviet threat to Western Europe, building a modernized, highly mobile U.S. military equipped with nuclear weapons from funds saved through shrinking the larger, wholly conventional forces they were to replace. In the early days of his presidency, Eisenhower's enthusiasm for nuclear weapons appeared to confirm that he had yet to fully digest the issue of fallout.

That initial omission reflected fallout's status as a vital intelligence secret and little more, even within the guarded confines at the apex of the American national security bureaucracy. The grim results of IVY MIKE confirmed the fallout predictions for thermonuclear weapons, the central problem of nuclear weapons strategy that troubled Oppenheimer and his GAC into raising it as an issue in the face of the Air Force's ambitious optimism for the new class of weapon. Along with the usual rough edges in the course of turning over power to a new president, during the early days of the Eisenhower administration the issue of fallout as a problem remained as deeply buried as possible, known only to a relative few in the AEC and at the Pentagon. Ike was likely simultaneously pleased and distressed at details in memos on Soviet fissile material production and estimated weapons stockpile rates produced by one of his most valuable classified assets, AFOAT-1.

Historical data on Soviet stockpile production is now available, making it possible to evaluate it against annual and cumulative American production in much the same way as highly classified AFOAT-1 intelligence and AEC production reports provided to the president and his closest advisers during the 1950s. The United States plutonium-239 stockpile during Eisenhower's first term rose from 1,400 kilograms in 1952, doubling to 2,950 kilograms by 1954, then reached 6,050 kilograms in 1956. The comparable figures AFOAT-1's krypton-85 monitoring program documented for the USSR cumulative stockpile were approximately 456

Committee was willing to endorse this proposal. The reasons for our views leading to this conclusion stem in large part from the technical nature of the super..."

[381] Letter to the Secretary of Defense from Dwight D. Eisenhower, 1 July 1953, Eisenhower Library, Ann Whitman File, DDE Diary, Box 12.

kilograms in 1952, 1,131 kilograms in 1954, and 2,081 kilograms in 1956. While the USSR clearly possessed a substantial arsenal and growing capacity to produce fissile material, the total Russian plutonium inventory remained at about a third of American holdings even as both nations rapidly increased their fissile material production capacities. Yet this was the same period during which the Air Force began asserting the potential for a growing "bomber gap" opening between U.S. and Soviet strategic forces. The data AFOAT-1 produced on the Soviet nuclear stockpile in no sense made sense in support of even a weak argument for American weakness.[382] The worst case argument spun by Air Force intelligence analysts from this data into the "bomber gap" (and the later "missile gap") possessed the same shape-shifting credibility as cotton candy; its appearance artfully concealed its lack of substance beyond the assumptions made by analysts.

What Americans Believed (and How to Change It)

In order to sell the public on the need to support change during the Cold War, shifting priorities in national security policy were often seen as a matter of proper marketing in the executive branch. Evidence for this marketing-based policy formation was extensive in Eisenhower administration documents. As Ike engaged with the Department of Defense over details of the New Look in the first years of his presidency, his staff was at work on his version of "Operation Candor" as the White House sought to take advantage of Stalin's death shortly after the president assumed office. Candor was an attempt to use straight talk in order to sway the American people to support Ike's national security policy. Among the first actions taken was extension of an invitation to Oppenheimer to discuss his views on "Armament and American Policy." [383] In fact, Oppenheimer had helped place the topic of candor about nuclear weapons on

---

[382] While Air Force analysts relied almost wholly on calculated speculation about Soviet bomber strength derived from krypton-85 monitoring provided by AFOAT-1 prior to the beginning of the CIA's overflight program, the Soviets were certainly aware of American capabilities due to the reporting of a generally free and open press in the West. United States strategic bomber strength was at 660 in 1952, a year after the jet-powered B-47 joined the World War Two-era B-50 and B-36 bombers. It grew to 1,470 bombers in 1956, the year after the first B-52 bombers went into service. In comparison, Soviet strategic force launchers, including missiles, were at 120 in 1956, rising to 250 in 1958, then fell off to 163 in 1965, when the United States had around 1,800 launchers available. The reason for the steep decline in Soviet strategic bombers was retirement of the bulk of the MYA-4 "Bison" fleet, an obsolete clone of the U.S. B-29, in 1960. http://www.nrdc.org/nuclear/nudb/datab1.asp; http://www.nrdc.org/nuclear/nudb/datab8.asp.

[383] Sherwin and Bird, *American Prometheus* , 462-470; Green, *Eisenhower, Science Advice*, 25-27; Cross Reference Sheet: Memo for the President from Robert Cutler, 24 May 1953, Eisenhower Library, Central File, Central Cross Reference, Box 88. Robert Oppenheimer gave a speech, cleared by the Eisenhower White House, to a closed meeting of the Council of Foreign Affairs in New York City in February 1953. He called for greater candor about the threat posed by nuclear weapons; a transcript was published as "Operation Candor" in the July 1953 *Foreign*

the table by virtue of acting as a consultant to a 1952 Department of State panel report on disarmament, which argued for candor about nuclear weapons as among its recommendations.

The idea of candor apparently appealed to Eisenhower. However, the new president's embrace repurposed it from a nascent disarmament proposal into an effort to garner public support and avoid panic in the face of informing Americans of the grim realities of the hydrogen bomb. This White House project also became known as Candor, including "Operation Edify." Originally proposed as a series of five television programs sponsored by the government to address various facets of national security, Ira Chernus argued "Edify" demonstrated that "Eisenhower and his advisors cared little about the domestic impact…" of the project, but the evidence seems to argue against this interpretation.[384] Robert Cutler arranged for a special showing of the then Top Secret film of IVY MIKE. Those invited included the Cabinet, presidential advisers, the Joint Chiefs of Staff and the service secretaries. C.D. Jackson, serving temporarily on loan from Henry Luce's Time-Life Incorporated as a special assistant advising Ike on psychological warfare, called for a campaign that was directed straight at the national security perceptions of the American public.

> The national will [emphasis in original] consists of the composite thought of the American people. They do not yet grasp the import of the President's recent words that we live in an age, not an instant, of peril. They do not fully understand the dangers that confront them, the power of the enemy, the difficulty of reducing that power, and the probable duration of the conflict.[385]

Affairs. Oppenheimer was echoing a call made as the first recommendation of a 1952 report issued by a State Department panel he chaired in 1952 on the problem of disarmament in the nuclear age. This was the apparent origin of Eisenhower's own call for candor about national security, but which Ike only largely embraced late in his second term, while still mostly omitting addressing fallout directly. The White House was provided with a transcript of the speech in May 1953 by C.D. Jackson, Eisenhower Library, Central Files, Official, Box 525. Along with Vannevar Bush, Oppenheimer received an invitation to discuss the issues before the National Security Council on 27 May 1953; thus, the White House was quite aware of the issues, including fallout, which Oppenheimer raised.

[384] Ira Chernus, "The Word "Peace" as a Weapon of (Cold) War," http://www.colorado.edu/ReligiousStudies/chernus/4820-ColdWarCulture/Readings/PeaceAsWeaponOfWar.htm.

[385] Abbott Washburn attachment to Claude Robinson letter to James Lambie, 23 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12. As part of the attachments to Lambie's solicitation of Robinson's assistance in polling public opinion in response to the threat posed by nuclear weapons was this paragraph in a memo written by Abbott Washburn describing the effort to organize Operation Candor. Lambie, Robert Cutler, Deputy Secretary of Defense Roger M. Kyes, and C.D. Jackson were all given credit for its formulation. Washburn was serving on the President's Committee on International Information Activities at the time. He went on to serve as deputy director of the U.S. Information Agency from 1954 to 1961. In that capacity, he was responsible for organizing the 1959 U.S. exhibit in Moscow, then suggesting to Richard Nixon that he escort Khrushchev on a tour. This established the set and opportunity for the famous "kitchen debate."

In addition to initiating the first national security television marketing campaign, another domestic marketing organization, the Advertising Council, suggested providing "vigorous follow-through…via all media."[386]

James M. Lambie, whose writ involved assisting development of "Operation Candor," frankly admitted the project was "a job of persuasion or indoctrination or propaganda."

> This is no more than a business corporation would do before launching a campaign. It would discover who comprised its market, what their prejudices and predilections [sic], what they knew and didn't know, what they would accept and wouldn't accept, etc., etc.

Lambie was disturbed by his initial research, in which a Gallup poll indicated that 60% of Americans pessimistically thought that Russian policy offered no "real change" with Stalin gone Lambie argued:

> There are two jobs. One is to find out what the story has to be. The other is to find out what will make people believe it and act on it.[387]

Later in July 1953, along with letters to other polling executives Lambie wrote to Claude Robinson, president of the Opinion Research Corporation, in order to engage his services to "make people aware of the great danger of Russian imperialism." Interestingly, Robinson expressed surprise to Lambie that Americans had yet to internalize the danger they faced by ironically – and likely quite unwittingly – citing the person at the center of the fallout controversy.

> The simplest answer that I can think of is just tell the people truthfully what we are up against. Mr. Oppenheimer, I think, made a good deal of sense in his recent article saying that we are denying the American public a great deal of information about the atomic bomb that the Russians already have…[F]olks in the grass roots can do pretty well in thinking through national issues if given the right kind of help.[388]

---

[386] Memorandum from Abbott Washburn to Sherman Adams, 15 July 1953, Eisenhower Library, Central Files, Confidential Subject, Box 12. Eisenhower had already tested the television waters by introducing several of his cabinet members on the air, then invoking the theme that was central to Operation Candor, "We live not in an instant of peril but in an age of peril."

[387] Memo from James Lambie to C.D. Jackson, "Research as an Aid to Operation Candor," 11 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12.

[388]Memo from Claude Robinson to James Lambie, re Opinion Research Corporation's interest in countering "the possibility of an atomic Pearl Harbor," 11 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12. The reference was to the Oppenheimer speech, transcribed as an article in *Foreign Affairs* that C.D. Jackson obtained from Oppenheimer and placed in file in May 1953. Oppenheimer visited the White House to brief the president and his staff in May 1953, so Jackson probably obtained the copy in connection with this visit.

A significant part of that denied information had to do with fallout in its problematic new role as a direct threat to personal security that extended far beyond the blast zone. Robinson suggested that "Gallup is always on the lookout for subjects which he can turn into newspaper stories."[389] This was hardly news to Lambie, as in addition to Robinson and Gallup, he had also written asking for advice to Elmo Roper, another pollster.

It was something bigger than Stalin's death that motivated Ike to pursue Operation Candor. The president and his advisors were clearly worried about how to bring Americans to understand the implications of thermonuclear weapons, foremost among which was the threat of fallout, while saying as little as possible to alarm them.

> The American public needs information concerning the growth of the Soviet atomic capability. This development brings the communities of the United States into the front lines. It places in doubt the claim that quantitative atomic superiority is a conclusive deterrent to attack.[390]

Lambie pointed toward the crux of the problem in another round of letters to the pollsters.

> If I were to try to state the problem, I should put it this way: we have not yet been able to convey to the American people the enormity of the threat that confronts them – including, but not limited to, the atomic situation.

In a July 1953 memo to Robert Cutler, Eisenhower's National Security Adviser, Lambie quoted William James on the "Moral Equivalent of War."

> When whole nations are the armies and the science of destruction vies in intellectual refinement with the science of production, I see that war becomes absurd and impossible from its own monstrosity.

Lambie added parenthetically, "And 'monstrous' is the word for what we got [sic] now."[391]

While fallout again appeared to have been implicated in general terms, Lambie was specifically describing his initiation into knowledge of the threat posed by fallout. Given that the supraconventional effects were unlikely to be termed "monstrous" or to make war "absurd," fallout gave every indication of being precisely the factor Lambie was elliptically referencing.

---

389 Memo from Claude Robinson to James Lambie, Opinion Research Corporation's interest in "the possibility of an atomic Pearl Harbor," 11 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12.

390 C.D. Jackson with National Security Adviser Robert Cutler and Deputy Secretary of Defense Roger M. Kyes, quoted in "Memorandum to Governor Adams from Abbott Washburn: Subject "Candor" (Lambie Presentation)," 15 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12.

391 James M. Lambie Jr., "Memorandum for General Cutler, Subject: Rationale of CANDOR or underlying philosophy," 29 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box12. Lambie's anxiety seemed to be driven by what was known about IVY MIKE among White House staff. Given Lambie's already shrill concern, one can only imagine the August 1953 first Soviet thermonuclear test was a further shock to the system.

What sparked Lambie's outreach for help in explaining a campaign by the Eisenhower White House to call the American public's attention to "an age of peril" was his staff's viewing film about the then still classified IVY MIKE test following Oppenheimer's presentation to the National Security Council a week earlier.[392] Shown on 1 June 1953 with Eisenhower in attendance, attendees included the cabinet, the Joint Chiefs of Staff and other Department of Defense officials, representatives of the AEC, civil defense, and various national security staff members. Lambie's name was not on the official invitation list, but his supervisor, C.D. Jackson, was and there were indications others not on the official invitation list with security clearances were accommodated to room capacity.[393] Certainly, Lambie was briefed on the situation the extent he was talking around it carefully in his correspondence to recruit pollsters and advertising executives to help develop an effective policy response to the challenge of thermonuclear weapons. In his interactions with public opinion research executives on how to better assess the beliefs of Americans about national security, Lambie's attention was undoubtedly called to relevant data already available.

What did the public believe about war in the nuclear age and how did this shift with Americans' increasing awareness of the threat posed by fallout? A Gallup Poll taken in October 1949, just after the first Soviet test was announced by Truman, showed a relatively modest concern about the atom bomb itself, with just 6% of Americans listing it as the most important issue for the government over the next year. A total of about 25% of respondents listed a broader concern with the threat of war, Communism, and the Soviet Union as the major issues over the next year. When asked specifically about Russian possession of the atom bomb, a much higher 45% thought this could lead to war. However, at this point, just 4% had given a thought to moving elsewhere to protect their family from such an attack. Rather too optimistically, 63% believed that science would develop a defense against the atom bomb in the next ten years. The Air Force's public relations efforts were clearly bearing fruit, as 65% believed the junior service

[392] *Operation IVY*, Joint Task Force 132, T.G. 132.1, Task Unit Nine, United States Air Force, Lookout Mountain Laboratory, 1952, https://www.youtube.com/watch?v=J8yHRZhdNd8.

[393] Robert Cutler, "[Invitation to Join the President at Film Showing, Joint Task Force 132]" 29 May 1953, Eisenhower Library, Central Files, Official Box 525. The film noted that it was anticipated fallout would become heavy one hour after the detonation, so survey crews faced the need to recover samples and other experiments quickly before radiation rose to prohibitive levels. The dialogue mentioned relatively little about radiation, noting the film's focus was on only the "primary" effects, but the fact that high levels of radiation were acknowledged was a new development that may have gone over the heads of the uninitiated.

would play the "most important part" in case of war.[394]

In spite of Truman's order of silence, the constrained debate over pursuing thermonuclear weapons was something Americans picked up on, slowly at first, then with increasing concern; in February 1950, 68% approved of building hydrogen bombs with a nearly equal number surprisingly believing the United States should also try to negotiate with the Russians to work out an agreement to limit such weapons. However, at the time only 18% of Americans were optimistic about successfully concluding such an agreement.[395]

By the summer of 1953, with Stalin buried, Americans remained fairly complacent about how they saw the threat of nuclear war, with between 38% and 51% saying that there "was not much chance" of their community being attacked, depending on how the question was asked.[396] In what might be the first poll question composed due to direct queries from the White House, Gallup Poll #520 asked whether "U.S. defense officials should or should not give the people more information about the destructiveness of the atom and hydrogen bombs?" Americans came down clearly on the side of knowing more, with 62% supporting better information.[397] The November 1953 appearance of Michael Amrine's article, "Too Much Secrecy Can Hurt," in *Air Force* magazine demonstrated the debate over the need for greater public knowledge of the effects of thermonuclear war extended into the inner sanctum of the service.[398] While the general narrative about civil defense and military preparedness was couched in purposefully non-specific language, as in Amrine's article, the bulk of such anxieties expressed by the few informed observers were engendered by the threat of fallout. There simply was no other topic of equivalent importance that differentiated thermonuclear weapons from fission and conventional weapons, even though this was an extraordinarily sensitive official secret, as Chapter Three will demonstrate. Fallout as a threat was already well within the imagination of many Americans.

Other questions in these polls showed generally less than 20% of Americans feared nuclear war would break out with the Soviets or that the Russians would prevail if it did occur. One can read such numbers in a variety of ways. They demonstrated a faith in both government

---

[394] Gallup Poll #449, 28 October 1949.
[395] Gallup Poll #452, 2-10 February 1950.
[396] Gallup Poll #517, 2 July 1953.
[397] Gallup Poll #520, 12 September 1953.
[398] Michael Amrine, "Too Much Secrecy Can Hurt," *Air Force*, Vol. 36, No. 11 (November, 1953). Washington, DC: Air Force Association, 41-45.

and science to develop the military tools to prevent war, but at the same time a majority optimistically believed the United States would prevail in the event of nuclear war.

These and other polls certainly drew the attention of military planners and other researchers working on the problems of national security in the "air-atomic age." Amrine, who earlier noted how the Air Force framed its pursuit of nuclear weapons as meeting the needs of its "customers," the American public, left no doubt selling the public on the new policy was not going at all well in mid-summer 1953.[399] Amrine summed things up by blaming "too much secrecy," where the U.S. government continued "to stamp CONFIDENTIAL on items now secret from none but our own citizens." Certainly this could be said about AEC's test program, but it applied even more conclusively in describing the rough outline of the capabilities of the American nuclear intelligence effort, in addition to the fallout problem itself, was revealed at its birth through the compromised agency of Kim Philby, a fact known to both British and American intelligence by 1953. Amrine condemned the fact that:

> This confusion is a direct result of the fantastic situation in which we pretend that we can keep our hydrogen development secret, while we boast that we can detect Russian bombs whenever we desire![400]

Amrine was an experienced and knowledgeable author who earlier worked in public information for the AEC at Brookhaven National Laboratory, as well as serving as managing editor of *The Bulletin of the Atomic Scientists*. Given his background and likely previous associations, there can be little doubt that his comment was in reference to the work of nuclear intelligence, perhaps even directly about AFOAT-1. His concerns spoke to the paradox of *nuclear absolutism*, the belief nuclear weapons were the greatest threat to national security at the same time they provided the ultimate security against just such an attack. Moreover, this security depended on blanketing secrecy to keep citizens in ignorance of the harsh realities of nuclear war, even when it was clearly not a sustainable policy.

Amrine speculated on the reasons for the somewhat confused picture polling provided on the views of the American public. Supplementing the polls, Amrine drew on additional interviews conducted by the budding disaster studies community, including those done at the

[399] Michael Amrine, "Too Much Secrecy Can Hurt."
[400] Ibid.

Institute of Social Research at the University of Michigan.[401] For many, Amrine intimated that the public must have concluded that possession of nuclear weapons was a quasi-magical solution to national security in the "air-atomic age." He blamed ignorance and education levels, because overcoming "simple ignorance was the answer to this mistaken belief in a magic Maginot Line around America." College graduates recognized by a margin of 46% that the military might not prevail in protecting the United States. "It was the most poorly-educated who expected the most protection." The AEC's 1950 *The Effects of Nuclear Weapons* was "written in language only an engineer could understand." Most critical of its errors, in Amrine's judgment, was that "because of secrecy and conflicting statements about radiation, the Michigan disaster studies research noted that many tended to exaggerate radiation effects. Such ignorance in turn was seen as prodding people to exaggerate the size of the civil defense problem, and waver between unreasonable fear and unreasonable complacency." Thus, at a time when scientific knowledge about fallout was minimal, with the primary use of fallout being for intelligence purposes, and with the Air Force sponsoring research that seemingly demonstrated the American public would best be kept ignorant of fallout, even after it was argued the public needed better access to the realities of "air-atomic" warfare, fallout was a topic that policy and predisposition caused the military to view as troublesome. In fact, as judged by many experts on national security, the public already knew too much, possessing "a strong tendency to exaggerate the radiation effects of A-bombs."[402]

What factors shaped such dismissive views, which Amrine and others associated with backstopping Air Force policy found troublesome in connection with discussion of fallout? As with Tomboy soda, extensive cultural evidence demonstrated a more complex picture of American encounters with radiation and fallout. Those who made up part of the various national security elites clearly felt that the public misunderstood the nature of these new weapons, focusing too little on their explosive power and other supraconventional effects and – already – too much on the problem of radioactive fallout.[403] Granted, at mid-century, most Americans did

[401] The Institute's chief was Rensis Likert, a former member of the U.S. Strategic Bombing Survey, a psychologist by profession.
[402] Michael Amrine, "Too Much Secrecy Can Hurt," *Air Force*, Vol. 36, No. 11 (November, 1953). Washington, DC: Air Force Association, 41-45.
[403] Over two terms, Dwight Eisenhower's several references to his fear of public "hysteria" about fallout will be noted, as it was the term that best summarized official anxiety about the unpleasant direction discussion of nuclear policy might take. The incidents range from discussion preceding the late 1953 "Atoms for Peace" initiative made in a speech to the United Nations' General Assembly to the 1959 "wheat scare" that hardened Eisenhower's

not understand radiation any better than they understood witchcraft. With few exceptions, physics was not a subject typically encountered in one's education prior to the post-1957 expansion of science education following the political shock of Sputnik's orbiting by the Soviet Union as the first satellite.[404]

The military understood those whose service required them to come into contact with nuclear weapons likely had insufficient or incorrect knowledge of what it considered to be the facts of fallout. This was not a one-time problem, but one that persisted and intensified. An example was the 1962 training manual, *Atomic Fundamentals*, used in training by the Defense Atomic Support Agency's Atomic Weapons Training Group for those "who lack a background knowledge of elementary nuclear physics." In basic terms, this brief book covered the fundamentals of radioactivity in order to provide "simple facts herein …essential for a proper comprehension of classroom instruction" up to the point where it reached critical mass.[405] This publication was just one example of the many disconnects existing between popular beliefs about nuclear power and what the government preferred citizen-soldiers should know about radioactivity. In this case, the term *fallout* was something troublesome enough to either save for later, more complex instruction or to be ignored altogether. Even in 1962, with fear of fallout hanging in the very air, amazingly enough, the term was simply not present in this textbook. Just as with much evidence of fallout's role in shaping policy, references to fallout where the circumstances clearly pointed to the need for its explicit presence in the narrative were often either cryptic or wholly absent. Discovering the full extent of the influence of fallout required minding the obvious gaps in the record where one expected to find it, but did not.

---

commitment to pursuit of a permanent comprehensive test ban, rather than only an atmospheric ban. While he generally sought a policy of "candor" in discussing the perils of the nuclear age, fallout proved to be one topic area where the president was most comfortable saying nothing, even when it was the strongest argument he could make about controversial policy.

[404] John L. Rudolph and David Meshoulam, "Science in American High Schools," http://www.amscied.net/Publications_files/Web%20PDF.pdf, 13-14. While Sputnik is often taken as the dividing line by historians of American education, nuclear weapons played an early role in the expansion of teaching physics in high school. The first major postwar effort to expand science education came about following a study by presidential science advisers that began in 1951. MIT physicist Jerrold Zacharias, who inadvertently played a small role in the Oppenheimer hearing that will be described shortly, chaired the Physical Science Study Committee (PSSC) that began meeting in 1956 to advance the level of science instruction at the secondary level. Of the three major divisions of science American secondary students typically encountered during most of the twentieth century, biology, chemistry, and physics, physics was least likely chosen to enroll in. Into the early 1970s, those studying physics typically anticipated college enrollment in the sciences. Another factor was that a prerequisite was usually two years of algebra, plus a year of geometry, with only diligent seniors qualifying.

[405] Atomic Weapons Training Group, *Atomic Fundamentals* (Sandia Base/Albuquerque, NM: Field Command, Defense Atomic Support Agency, 1962).

Boy Scouts Help Nuclear Waste to Rest in the Ocean

Alongside institutional fear of Americans' unfounded or exaggerated fears of radiation coexisted complacency about the invisible threat it posed. Organized civil defense was part of the government's answer to that aspect of some Americans relationship with the Bomb. As an organization founded on disciplined, paramilitary lines, the Scouts already had considerable involvement in civil defense, with the experience of WWII still fresh. Andrew Grossman noted one project of the early days of the Cold War civil defense revival was to encourage Boys Scouts and other youth groups to engage in promoting civil defense education and organization efforts at the national, state, and local levels.[406] In 1951, the national office of Boy Scouts of America produced a series of educational booklets on civil defense for Scout leaders, Scouts, and their families. For the most part, these suggested training, exercising, and organizational methods that relied on reinforcing familiar scouting skills. In the leadership manual, virtually the only thing said about the "realities of the air-atomic age" invoked by Amrine was a recommended "atomic survival demonstration."

> In order to avoid panic, caution must, of course, be used in presenting the subject of atomic attack to the general public. However, Units can perform a great service in their communities by colorfully presenting the steps necessary to protect himself in the case of such an attack.[407]

In another title in the series, the standard approach to minimizing the threat of fallout – in fact, it again completely avoided use of the term fallout – was a reminder that a ground or water level burst height could result in "radioactive dirt or rain," but this was survivable by staying indoors for "one hour, 24 hours if possible." In a foreshadowing of some of the more frightening and less useful post-September 11 recommendations, covering broken windows with cardboard and tape was also described as useful. However, in this pre-transistor era, operation and interpretation of radiological monitoring instruments was a matter for specialized teams, who would recommend whether evacuation was necessary due to radiation. This stood in contrast to how such programs evolved by the end of the 1950s, when there was a decided shift to emphasize putting such instruments more widely in the hands of the public as technological advances (like the transistor) and higher production quantities made them more affordable and widely distributed.[408]

---

[406] Grossman, *Neither Dead nor Red*, 81.
[407] *Pattern for Survival: A Guide for Unit Leaders* (New York: Boy Scouts of America, 1951), 53, author's collection.
[408] *Family "Be Prepared" Plan* (New York: Boy Scouts of America, 1951), 15-16.

The Boy Scout motto of "Be Prepared" has thankfully never been tested in actual wartime civil defense conditions involving nuclear weapons. However, some Scouts found themselves in surprising situations, which nevertheless challenged contemporary official pronouncements of safe, controllable nuclear energy, as well as suggesting a relatively benign public fear of radiation as the 1950s opened. Among the most shocking was a remarkable field trip some 75 Scouts took in October 1949 from the Philadelphia Navy Yards. The mother of one of the Scouts, the charmingly-nicknamed "Beetle," described details of the trip in a letter to his father, who was away in the Navy. With the letter was the mimeographed announcement for the trip, with the missing lower third of it apparently being the release families needed to sign and return – "Navy releases are a must." – to allow their son to participate in a weekend cruise leaving from the Philadelphia Navy Yard.

Their ship was the PCER 853, a WWII-vintage patrol craft nearly 200 feet long. Leaving port, the 853 continued east until it was some 60 miles off the Atlantic coast from Philadelphia. Scouts were assigned to duties at various stations, supervised by naval crewmen; Beetle was skilled enough to be assigned as head of the Communications division, with nine other Scouts under his command. Working under the ship's captain, Lieutenant Potter, Beetle took readings from the fathometer of the ocean's depth, but he also had to scramble with other duties, as the heavy seas and fog made all but one of the other Scouts assigned to duty at the helm seasick. Beetle cleaned up after them as best he could, but the excitement was just beginning, as Beetle's mother described to his father about how he assisted the seamen in completing the cruise's other mission.

> On the fan tail there were 20 drums of radioactive paint and clothing from Bikini. It was roped off and signs and all warned not to go on the fantail. Well at 10:30pm the Capt. called down this is the place we are supposed to dump the cans.
>
> So Sprague got two broom handles and he, Baker, and Beetle went to push them over. They unroped them and Sprague shoved one with the broom handles. It hit a hole in the can and went into the hole and he couldn't get it out. That left only one pusher stick to push with. They finally got them all over but the last 3. By this time these three were well back on deck away from the end. They pushed and couldn't move them, they were so heavy. Remember what they were pushing and it was 10:30 at night in a rough sea with only a two inch edge to keep them from going over with each shove. At last Sprague went in and got some rags and they

> wrapped their hands up and pushed the last three over by hand. So we hope all is well![409]

Atomic optimism, indeed! Surely participation in such a project would shock the parents of any Boy Scout in more recent memory, if asked to sign a permission slip for such an outing.[410] In spite of how we might view the risks posed by such an exposure now, the tone of the letter by Beetle’s mother suggested she, Beetle, and apparently Beetle’s father (who the letter was addressed to) most likely took the unexpected additional activities of that windy, foggy night off Philadelphia in stride. There was no indication the letter was saved for any other purposes than its fascinating, unique plotline. It showed no particular worry or trepidation of the events, other than the chance of Beetle losing his footing and slipping overboard.

The incident demonstrated the banality of existing views among much of the public about the risks from radiation, despite officials who viewed them as likely to panic if told about the risks of contact with radioactive substances. It was still five years before the world first learned there was substance to reports fallout was dangerous, due to the fallout plume generated by the 1954 CASTLE BRAVO test. However, after nearly five years of reassurances about radiation as something closely controlled by government policy and practice, the letter was substantive cultural evidence that in 1949, just after the first Soviet nuclear test, many Americans shared relatively little concern about exposure to fallout and other radioactivity.

Writing about the history of ocean dumping of radioactive waste, Jacob Hamblin noted ocean dumping was fraught with the fears of scientists concerned “the biological effects of atomic radiation were too emotionally charged to be discussed rationally…the notion of public irrationality, particularly the public’s visceral fears of all things connected to radioactivity, was a common thread in discussions of the issue in newspapers, official statements, and even scientific reports.”[411] However, at this remove and in light of evidence that Americans held a variety of opinions on the risk of radiation, it could well be that the hand-wringing by various elite interest groups was more a projection of their own ignorance, uncertainties, and emotions about radiation and fallout onto the public, rather than vice versa.

---

409 Mrs. MWH to Mr. H, letter, 30 October 1949, author’s collection. Letter written on stationary monogrammed “MH” and signed as “MW,” but no further information about the author is available.
410 Since the permission slip itself was missing, it is unknown whether it apprised parents their Scouts would have the doubtful opportunity to “handle real, live atomic waste!”
411 Jacob Darwin Hamblin, *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age* (New Brunswick, NJ: The Rutgers University Press, 2008), 7.

Contextualizing the Scouts' trip to send the waste to its watery grave, Hamblin noted the problem of waste disposal was one the AEC was reluctant to address. The British had some 'expertise' with ocean dumping, in part because they had little in the way of remote, unoccupied lands to rid them of no longer useful radiation, which the United States relied on. The solution to mass disposal was not drums dropped off-shore, in the view of the British, but was to send it to sea in pipes leading off-shore, shrouded in secrecy.

Hamblin also discussed the AEC's lack of commitment to underlying its policy with science, because even when it solicited advice to "assess existing knowledge" from independent panels, "a new study was precisely what the AEC did not want," since it would be met "with requests for research funds," rather than the "definitive conclusions" it hoped to gain on the issue of radiation in the environment. This lack of interest by the AEC in expanding the pool of researchers working on the environmental problems of radiation joined with a lack of regulation and recordkeeping, as both the Navy and the Coast Guard assisted other federal agencies in ocean dumping, demonstrated due diligence was clearly a lower priority than facilitating arms production. This was even the case among institutions whose internal knowledge might indicate a better application of caution than their actions subsequently suggested. Both the National Bureau of Standards and the Public Health Service used the Coast Guard to dump their waste. Lauriston Taylor of the Bureau of Standards disposed of nearly a hundred drums of waste, but as Hamblin found, "no one seemed to be keeping track."[412] Thus, the actual source and contents of the barrels the Scouts helped dump on a foggy night in 1949 will likely prove difficult or impossible to verify independently at this point.

Even among those few who understood the issue, fallout was clearly recognized at the time as a threat linked almost solely to potential wartime use of large numbers of nuclear weapons. Moreover, Forest Western, assistant director of the AEC's Health Physics Division, observed that the most persistent problems of nuclear war were likely to go far beyond blast

[412] Hamblin, *Poison in the Well*, 33. Taylor subsequently became president of the National Council Radiation Protection and Measurements and was author of *Radiation Protection Standards* (Cleveland: CRC Press, 1971). In 1948, Taylor was loaned by NBS to the AEC to organize the Biophysics branch of the Division of Biology and Medicine, and then in 1949 "he organized 'Project Gabriel' to evaluate the long-term implications of strontium-90 in fallout." It must be noted that this description actually conflated GABRIEL with Project Sunshine and elided the way the latter was used to conceal the original research question raised by the former to determine the limits of nuclear war discussed here as GABRIEL. After retirement from NBS, Taylor began a personal campaign against those raising concerns about the adequacy of radiation protection standards, documented in a lengthy memoir held at the American Physical Society's Niels Bohr Library and Archive.

effects.

> The populations of large areas may find the air that they breathe, the food they eat, the water they drink, and perhaps anything that they touch contaminated with harmful quantities of radioactive materials.[413]

Bad as wartime fallout might be if fought with fission weapons, proposals for radiological warfare, using what are now referred to as "dirty" bombs, posed other radiation problems, like storage and logistical support before use. Interestingly, Senator Albert Gore, Sr. (D-Tennessee) suggested to Harry Truman a zone of lethal radioactivity be laid across the Korean Peninsula. Besides the obvious overtones of imperialism and racism implicit in an American proposal to poison land in East Asia, the idea was considered impractical by the AEC, even if such use of radioactive substances were, as Gore claimed, "morally justifiable" under the law of war when used as a deterrent, rather than as an attack on civilians.[414] Gore's formulation was another nagging reminder of the fear of many inside the government who quietly worried that the use of nuclear weapons and the fallout they generated already skated close to the boundary line of being a war crime.

Hamblin also offered an insight into an AFOAT-1 contractor, Tracerlab Inc., used extensively for laboratory support during the early era of testing.[415] In addition to this secret work, Tracerlab was also involved in promoting the wider use of isotopes for industrial purposes, regularly receiving and marketing isotopes it purchased from the AEC. One of Tracerlab's researchers, F.C. Henriques, permitted his radioactive zealotry to go too far, violating provisions of his agreement with the AEC that restricted use of iodine-131. The Subcommittee on Human Applications of the AEC's Committee on Isotope Distribution reprimanded Henriques to the extent that "a recurrence of this type of violation will result in stopping shipments of radioactive materials to Tracerlab, Incorporated, and a thorough review of the entire situation by the highest authority in the Atomic Energy Commission."[416] Henriques was eventually let go from Tracerlab in 1951 under unspecified circumstances along with several colleagues, which was called "a

---

[413] Hamblin, *Poison in the Well*, 20-23.
[414] Ibid, 26.
[415] The Tracerlab branch that supported AFOAT-1's Western Field Office at McClellan AFB was assigned its own Detachment number, F-101TL, as was another at Tracerlab's Boston headquarters, 112. See Appendix E.
[416] Hamblin, *Poison in the Well*, 24; S. Allan Lough to various doctors, 19 July 1949, Tab F Early History, Briefing Book, Fifth Meeting, 25-26 July 1949, Advisory Committee on Human Radiation Experiments, National Security Archive, George Washington University, http://www.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet5/brief5/tab_f/br5f3e.txt.

serious loss" by AFOAT-1, This prompted AFOAT-1 to suggest the scientists by reinstated as "Air Force consultants," an idea quickly rejected by Tracerlab. Given the earlier problem that raised its head in the spring of 1949, it threw some additional light on the sometimes incestuous and self-serving nature at work in the network formed among those cooperating under the cover of secrecy on nuclear projects during the immediate postwar period. It would have been most problematic if Tracerlab lost its authority to receive and process radioactive materials just when the Air Force found it was needed most, as those capabilities often rested on employment of specifically cleared individuals.

Consider also the U.S. government already had in place specific standards sharply restricting experimentation with radiation and children. Thus it was rather chilling to know Boy Scouts were involved in the rather haphazard, hands-on disposal of nuclear waste. Beetle's narrative of ocean waste dumping suggested a culture of benign acceptance of radiation, where no one stopped a questionable practice because they assumed the government could be trusted to advise them if such a hazard were present.

Spencer Weart correctly located the origins of widespread nuclear fear in the existence of the bomb itself, but official efforts to elide fallout's significance because of its intelligence role show plenty of evidence these efforts paid off in dampening such concern prior to CASTLE BRAVO.[417] The incident involving poor record-keeping nonetheless demonstrated that early on Tracerlab had specific, timely expertise working with short-lived isotopes such as iodine-131, given that the archival record remains incomplete regarding the history of some of the more relevant isotopes utilized for nuclear intelligence purposes by AFOAT-1. This slapdash work by AFOAT-1's major contractor, together with the slipshod involvement of children to assist in disposing of nuclear waste by means of ocean dumping and the alarming idea that nuclear waste had a potential role in warfare, along with other evidence examined so far, lends itself to the conclusion that before 1954, the tendency to treat radiation as more of a nuisance than a threat was widely established as effectual, if not official policy. This view provided a context for

[417] Weart, *Nuclear Fear*, index. While it does list fallout unlike some of the more egregious omissions in other secondary sources used here, similarly to some Weart's index has no separate listing for CASTLE BRAVO, subsuming it under "Tests" with two brief cites. While Weart did not explicitly suggest CASTLE BRAVO lacked significance, his treatment of the incident seemed to minimize it by placing it more as a data point on a continuum of increasing public awareness of fallout than as a policy problem that became a watershed moment in how the government itself saw the issue. In Weart's defense, even when he wrote in the mid-1980s much of the evidence presented here remained classified, presenting experts in the field with little to fashion narratives that could challenge the official account.

making decisions that heedlessly spread radiation in the environment. Even if the science had been more definitive about the threat it posed, fallout was at the time a key source of intelligence data obtainable by no other means, so was too important to do without.

The Problem of Surprise Attack

The relative lack of hard information on other Soviet capabilities despite the success of the scientific approach to nuclear intelligence he initiated half a decade before suggested to Eisenhower the need for new approaches to the overall U.S. intelligence effort.[418] Eisenhower's greatest fear upon taking office was the possibility of a surprise attack because of the paucity of intelligence on the Soviet Union's actual military capabilities. Fear of political fallout from an "atomic Pearl Harbor" became pervasive once the Soviet Union possessed nuclear weapons.[419] Even the absence of an attack worried the president, as the confrontation between the United States and the Soviet Union created a situation where the lack of actual armed conflict, even in the midst of an arms race, left both nations – as he noted in April 1953 – with "a burden of arms draining the wealth and labor of all peoples…it is humanity hanging from a cross of iron."[420]

Shortly before that speech, in the hopeful first spring of his presidency Eisenhower waxed philosophical on keeping peace and the challenges of the arms race. Days before Stalin's death suggested potential change in the East-West confrontation, Ike found himself in the driver's seat of the arms race with his erstwhile wartime ally as he pursued the parallel course of peace through strength. Nuclear weapons were a fact of life, so much so that he found himself invited by the AEC in late February 1953, along with the National Security Council and the news media, to attend an "open" shot televised live from the Nevada Test Site, near Las Vegas. A flurry of memos between the White House, the AEC, and media representatives attempted to sort out the intricacies of commercial sponsorship and acceptability of ad copy. Ike decided to keep his personal distance, so he directed "there will be no statement to the effect that the White

[418] Redacted memo by Gen. Dwight Eisenhower assigning long range detection of nuclear explosions to the Army Air Forces, 16 September 1947. Reproduced in AFTAC, *A Fifty Year Commemorative* History, 4.
[419] Claude Robinson letter to James Lambie, 23 July 1953, Eisenhower Library, Central Files, Confidential, Subject, Box 12. Robinson was president of Opinion Research Corporation and was responding to Lambie's request for assistance with White House efforts to formulate public outreach to support Eisenhower's national security strategy. Robinson was responding to the packet of information that was earlier cited in connection with its discussion of leveraging the "national will" of Americans to meet the challenge of thermonuclear warfare. Robinson suggested working with Gallup to formulate questions to gauge U.S. public opinion about nuclear weapons, war and, eventually, fallout.
[420] Philip Taubman, *Secret Empire: Eisenhower, The CIA, and the Hidden Story of America's Space Espionage* (New York: Simon & Schuster, 2003), 27-8.

House okayed the move." Suddenly, here was the famously reticent, cautious commander dodging a virtual blind date with ANNIE (16 kiloton, 17 March 1953). ANNIE brought the iconic image of a nuclear explosion live into the living rooms of a significant, yet still not large number of Americans already part of the television age. Despite the president's desire for non-attribution, his secret approval of the plan ironically foreshadowed what became known as his own Operation Candor, in which he hoped to rally Americans to support the need for realism about the threat posed by nuclear war. Val Peterson, director of civil defense, hoped the event would stir what he saw as lagging volunteer interest in civil defense.[421] With support from the White House, quick AEC approval of televising ANNIE was the opening salvo in a major White House public relations effort to muster public support for national security goals for nuclear power, military and peaceful. Before CASTLE BRAVO, the broadcast of ANNIE made sense. What you see is what you got. After the spring of 1954, people wanted to know more about what was unseen – fallout – than what was apparent to the naked eye.

Behind the scenes and perhaps specifically unknown to the president loomed awareness there might be a problem. Project GABRIEL effectively came to a close in the summer of 1953 with a conference organized by RAND Corporation to assess its findings.[422] Shorn of its original goal of determining the megatonnage necessary to bring about widespread damage from fallout, in other words, to determine the limits of nuclear war, it sputtered to a rather inconclusive end.

> For shots whose mushrooms stay below the tropopause (approximately 100KT or less), time for 50% of debris to be deposited on the earth's surface is 20 days (PE-factor of 1.5).
>
> For larger shots, whose clouds penetrate well into the stratosphere, there is essentially no information pertinent to rate of fallout. It is expected, however, that the higher the yield the less rapid the fallout. As a result of slow mixing of stratosphere and troposphere, half time for fallout could be several times as long as for troposphere debris.[423]

[421] Morse Salisbury, Director, Division of Information Services, AEC, Letter to James C. Hagerty, Secretary to the President, 26 February 1953, Eisenhower National Library, Central Files, Official, Box 525.

[422] Hacker, *Elements of Controversy*, 183-184. Hacker's narrative suggested GABRIEL continued after the 1953 conference, but acknowledged that technically, "Sunshine emerged as the only major research effort supported solely by Project Gabriel." Apparently, after the conference GABRIEL survived as a coded compartment for compiling information about "long-range radiological hazards."

[423] USAEC, "Attachment One, Report on Project Gabriel," July 1954, http://www.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet11/brief11/tab_i/br11i1a.txt.

With just a single thermonuclear shot to base its conclusion on, IVY MIKE in 1952, the GABRIEL report demonstrated the AEC was aware thermonuclear weapons were a game-changer due to fallout, but was not yet sure what the new games rules would be.

With the AEC's evolving views on the implications of fallout unsettled in the fall of 1952 before IVY MIKE, others like Stefan Possony, DOD representative to the Psychological Strategy Board, embraced the need to persuade the public to reject what he claimed was a misperception spread by the Russians that Americans' "preoccupation with the atomic bomb rather than with atomic energy allegedly is indicative of the warlike character of present American policies." Possony suggested "a new and truly attractive atomic program…[to demonstrate] atomic energy is being used for constructive ends." According to Kenneth Osgood, Possony concluded "U.S. reliance on nuclear power imposed a psychological constraint on American foreign policy…"[424]

In the short term, Possony undoubtedly contended with how IVY MIKE's fallout made his objective of putting an optimistic face on nuclear power more difficult. Given most details of IVY MIKE were suppressed by classification and the shot itself remained a secret until CASTLE BRAVO exposed the fallout issue, IVY MIKE initially precipitated no public reaction against fallout. Whatever changes were made behind walls of secrecy to address the looming fallout problem, they appeared to be ultimately ineffective, and consequently blew up far more publicly at CASTLE BRAVO. This suggested Possony's 1952 advice initially went largely unheeded; the very idea constraints came attached to nuclear weapons was a tone particularly unpopular in 1952 inside the government, too.[425] In Possony's formulation, the issue of fear created by nuclear energy was largely psychological, a belief echoed in Spencer Weart's theoretical approach to "nuclear fear" that followed some thirty years later; both shared the same brittleness when exposed to the thorny problem of fallout. Both argued fear of fallout exposures did not originate in empirical reality, but rather was an inappropriate emotional reaction originating in the mind, best addressed by the study of various forms of human interaction with it.

Oppenheimer: Silenced, Marginalized, and Moving On

J. Robert Oppenheimer, already aware of efforts to marginalize him at the AEC as McCarthyism raged, sought to continue his public service by resisting the gathering storm in part

[424] Osgood, *Total Cold War*, 156.
[425] The ordeal of Robert Oppenheimer, related in the next chapter, will make clear just how unpopular such ideas were.

through his outside work as a consultant following stepping down as GAC chair in June 1952.[426] Ironically, these efforts set in motion the end game for those seeking to end his government career. Oppenheimer chaired a Department of State panel that delivered a report on the prospects for disarmament discussion with the Soviet Union to Dwight Eisenhower as he took office having just absorbed the grim thermonuclear reality IVY MIKE's success foretold. Bleak and with few credible options, as it should have been with Stalin still alive, the paper urged some adjustments like improvements in air defense and measures to assess and limit the possibility of accidental war. Its call for candor has already been noted, as well as the distinctly different twist when the term, but not the essential idea, was adopted by Eisenhower. The actual point Oppenheimer made was unstated, but clear, when understood in the context of an era still on the cusp of the thermonuclear age.

Left unmentioned, its most salient point was about fallout, one Oppenheimer drove home as a first step in his suggested policy of candor over the risks threatening American national security.

> The United States should adopt a policy of candor toward the American people, by revealing fully the nature of the dangers engendered by the atomic arms race.[427]

It was arguably difficult at that point to suggest Oppenheimer intended "revealing fully the dangers" to do nothing more than explain thermonuclear weapons' exponentially greater explosive power or thermal pulse, the supraconventional effects of fusion weapons already so familiar to most of the postwar world's population. "The nature of their dangers" seemed to frame these classified dangers as a qualitative difference, not a quantitative one.

The JCS suggested Eisenhower reject a full-blown discussion of "the terrifying aspects of the current situation," because it would have been difficult to rally "the American people to support unpopular measures by disclosing disagreeable facts about nuclear weaponry." While the JCS concurred in the sanitized version of Candor eventually developed as policy by Ike, it was clear their concerns were focused on, first and foremost, the newly understood if nonetheless most disagreeable fact about the "effects of weapons" – fallout.[428] Given the familiarity of

---

[426] Hewlett and Holl, *Atoms for Peace or War*, 37; Patricia J. McMillan, *The Ruin of J. Robert Oppenheimer*, 151. Bird and Sherwin, *American Prometheus*, 465-484 passim; Greene, *Eisenhower, Science Advice*, 23.
[427] Text of Oppenheimer paper cited in Robert J. Watson, *History of the Joint Chiefs of Staff, Volume V, The Joint Chiefs of Staff and National Policy, 1953-1954* (Washington, DC: USGPO, 1986), 189.
[428] Ibid, 190-191.

Americans with the supraconventional effects of nuclear weapons and the fact that the term "weapon effects" was frequently used at the time as an elision of or allusion to fallout and other radioactive effects, that it was clear the topic under discussion, which dare not speak its name even in the declassified version created for public release in the 1986 JCS history, was fallout. And the person most responsible for forcing a discussion about the perils of nuclear weapons at that point was none other than Robert Oppenheimer.

Hewlett and Holl illustrated how the slippery language used to bury what was actually at stake in the discussion persisted by its incorporation of a smothering vagueness into the historiography of the early Cold War. Acknowledging "that few people, even inside the government, understood the special character of the nuclear arms race," the authors then returned to the familiar and pedestrian in the world of 1953 to account for this "special character": "the frightening acceleration of the arms race…the destructive force of the weapons in the stockpiles was increasing rapidly..."[429] All true, but also largely a rehash of the same deceptive yet vague language that insisted on framing the effects of nuclear weapons as exponentially larger than those of conventional weapons, but otherwise not qualitatively different. The specific point of what this "special character" of thermonuclear weapons being avoided so judiciously actually was: the threat their fallout and other radiation effects posed, magnified to lethal peril across vast areas.

When the NSC sat to discuss the paper in the spring of 1953, Eisenhower at first rejected the idea of candor, an idea Secretary of Defense Charles Wilson argued "seemed foolish to scare our people to death" with, along with several ancillary suggestions of greater openness, including giving the American people a rough idea of the size of the American stockpile.[430] Eisenhower continued to hold back news the "super" had been achieved until after the CASTLE BRAVO shot verified the U.S. possessed a weaponized version of the thermonuclear design in the spring of 1954 amid the pressure of news reports about the fallout incident. Yet this passage made clear fallout was identified as the major problematic effect long prior to CASTLE BRAVO. In fact, too literal a focus on CASTLE BRAVO as the watershed event in understanding fallout effect on

[429] Hewlett and Holl, *Atoms for Peace and War*, 42-43.
[430] Osgood, *Total Cold War*, 156-157. See Appendix B. In fact, the United States remained well ahead of the USSR in plutonium-239 production. The cumulative total for the U.S. in 1953 was 2,100 kilograms, while the USSR had roughly 806 kilograms.

policy elided the fact that Oppenheimer's fate was sealed prior to CASTLE BRAVO because of the stance he took against treating fallout as lightly as the Air Force did.

The Air Force saw Oppenheimer's growing concerns about fallout as an indirect attack on the effort to build the "super," part of what it saw as a much larger narrative of systematic betrayal by him that put two of the Air Force's most important strategic programs – thermonuclear weapons and the long range detection system – at risk. Between the two, the Air Force arguably saw the danger to AFOAT-1's operations as more immediate. The service feared blowing the cover on its nuclear intelligence operation would threaten a variety of negative outcomes, even though by 1953 the Pentagon knew of Kim Philby's compromise of AFOAT-1's existence and mission to his Soviet handlers. The bigger, longer term problem as the military saw it was fallout's potential to spark inquiry that would drag the question of the feasibility of nuclear war into the glare of public knowledge. It might shut down American testing, just as it might cause the Soviets to consider underground testing or other measures to frustrate Western monitoring efforts. For the JCS, revelations about fallout posed an existential threat, not simply to vital intelligence sources, but to the bomb itself.

Given Sean Malloy's description of General Leslie Groves' early identification of fallout as a most sensitive topic, even in general terms the Pentagon saw the State disarmament report as problematic. Far more than lack of sufficient enthusiasm, the JCS perceived Oppenheimer as aggressively striking out at the "super" program in a cleverly concealed manner – via fallout – in yet another attempt to bring it to a halt. Combined with the political paranoia of the era, from low to high the reaction from the Pentagon and the AEC under the aegis of Lewis Strauss communicated a powerful message that drawing attention to the disquieting reality of fallout was unpatriotic, if not outright subversive. The Department of State's Oppenheimer disarmament panel's recommendations represented an audacious challenge to military prerogatives in policy and planning affecting what the Air Force considered its most vital weapon.

Conflicting Versions of Candor, With and Without Fallout

Eisenhower's reaction to the advice provided by Oppenheimer in the course of meetings over several years' time when the issue of fallout was clearly in play because of the topic matter. Despite the rigors of secrecy, what is known about Oppenheimer's concern about fallout can be illuminated by identifying and understanding the influence of its effect on the president's changing views on nuclear strategy, nuclear weapons and both explicit and implicit policy on fallout. The best documented of these visits was to the White House prior to things falling apart for the scientist with the suspension of his Q clearance in December 1953, a conflict that led to the 1954 AEC hearing that is the main topic of Chapter Three.

In late May 1953, Eisenhower read an unclassified presentation by Oppenheimer in preparation for a presentation by Vannevar Bush and Oppenheimer to the National Security Council on 27 May 1953. Oppenheimer had presented it to the Council on Foreign Relations in February and a version was cleared by the AEC and published in the July 1953 *Foreign Policy*. Excerpts from it point to Oppenheimer's concern about the need to address the problem of cumulative fallout.

> …we should all know – not precisely, but quantitatively, and, above all, authoritatively – where we stand in these matters.
>
> We have from the first maintained that we should be free to use these weapons; and it is generally known we plan to use them. It is also generally known that one ingredient of this plan is a rather rigid commitment to their use in a massive, initial, unremitting strategic assault on the enemy.
>
> We need strength to be able to at least ask whether our plans for the use of the atom are, all things considered, right or wrong.
>
> …first is candor – candor of the officials of the United States Government…we do not operate well, when the important facts, the essential conditions, which limit and determine our choices, are unknown. We do not operate well when they are known only, in secrecy and fear, to a few men.
>
> …knowledge of the characteristics and probable effects of our atomic weapons, of – in rough terms – the numbers available, and of the changes that are likely to occur within the next years; this is not among the things to be kept secret.
>
> There are many arguments which have been advanced against making public this basic information. Some of these arguments had merit in times past. One is that we might be giving vital information to the enemy. My own view is that the enemy has this information…It is largely available by other means as well. It is also my view that it would be good for the peace of the world if the enemy knew these basic facts – very good indeed, and very dangerous if he did not. [431]

[431] Robert Oppenheimer, "Atomic Weapons and Foreign Policy," transcript of speech delivered to the Council on Foreign Affairs in New York City, 17 February 1953, noted as filed by C.D. Jackson, Eisenhower Library, Central Files, Official, Box 525; Robert Cutler, "Memo for the President," 24 May 1953, Eisenhower Library, Central Files, Central Cross Reference, Box 89. Oppenheimer noted security restrictions meant his discussion "…must tell about it without communicating anything. I must reveal its nature without revealing anything." Fallout is not mentioned specifically, but the context and his use of the term "reveal its nature" suggests that cumulative fallout was the topic in what were forced to be his oblique references to the subject matter. He substituted the term "arms race" because it

Oppenheimer's version of candor forthrightly included fallout, as there was no other weapon effect that fits the logic here. Oppenheimer was saying everything he could say in public to indicate cumulative fallout was the pivotal factor to consider as he attempted to convey that message the constraints reliance on thermonuclear weapons imposed.

The president's subsequent selective embrace of candor was perhaps driven as much by an effort to distance himself from the increasingly politically suspect Oppenheimer as by any real disagreement with the idea of candor or indeed about fallout itself. The president certainly embraced candor conceptually, including a watered-down version of it in his "Atoms for Peace" proposal delivered to the United Nations in December 1953.[432] Relabeled internally as "Wheaties," Eisenhower was clearly knowledgeable, but unprepared to face the issues the extraconventional effects of radioactive fallout raised in 1953.[433] True candor prompted by thermonuclear weapons required, first of all, candor about the dangers posed by their cumulative fallout, a reversal of the existing circumstance where the "special" character of nuclear "weapon effects" was so often discussed at length, all while studiously avoiding mention of the word fallout. There was no other issue of primary significance other than fallout present in such discussions and fallout was still Top Secret, not blast or fire.

---

was apt, but also because it was a human-construct by which comparison could be made to the inherent and unalterable nature that he was attempting to communicate about that was the distinctive danger of thermonuclear weapons. Given Oppenheimer's acceptance of fission weapons and their use against civilians, as well as their limited fallout without alarm, the unique property of thermonuclear weapons left for him to object was their potential to generate dangerous levels of cumulative fallout. National Security Adviser Cutler's memo indicated he was passing the article on the president requested by Oppenheimer and confirmed his and Vannevar Bush's upcoming 27 May 1953 appearance before the NSC to discuss "Armaments and American Policy." The article was initialed by the president to indicate he did receive it and most likely read it.

[432] Oppenheimer's May 1953 presentation to Eisenhower, his cabinet and national security advisers was a classified version of his February 1953 unclassified speech presented to an invitation-only Council on Foreign Relations meeting. It was generally positively received at the time, excepting Lewis Strauss and the Pentagon. Oppenheimer also received clearance to publish the unclassified speech as an article, which appeared in the July 1953 *Foreign Affairs*. Strauss and the military quickly turned the tide of sentiment against the scientist, rather oddly apparently without informing the president the Air Force had already withdrawn his security clearance. By June 1953, the month Ethel and Julius Rosenberg were executed after Eisenhower refused them clemency, "Candor" was replaced as the code name for the effort by "Wheaties," supposedly because discussion about it happened in breakfast meetings. The timing and context suggested that the White House, while desirous of incorporating some of the Oppenheimer Panel's ideas into policy, wanted to dissociate the president's initiative from Oppenheimer's.

[433] Greene, *Eisenhower, Science Advice*, 45-48. It took months of argument between the president's advisers before the first significant initiative based on Oppenheimer's urging of increased candor with the public about nuclear weapons, Eisenhower's "Atoms for Peace" speech presented at the United Nations in December 1953. Even in spring 1959 as he told his advisers rising strontium-90 levels in wheat convinced him of the need to end all testing, Eisenhower still shied away from the potential "hysteria" he feared would be stirred by directly describing the threat it posed to the public.

The Air Force's reaction to Oppenheimer's report on top of simmering existing conflicts then quickly expanded, breathing life into a lengthier, far more painful process that culminated in the 1954 AEC personnel security board hearing that permanently stripped him of his clearance. That is what this project turns to next. Even as Oppenheimer was finally silenced within the government, as well as in public, on the matter of fallout, recognition of the empirical perils of radiation occurred far more quickly behind closed doors than in public. Delay and obfuscation would rule the day until the persistence of fallout won out over bureaucratic inertia.

Chapter Three: Fallout, Robert Oppenheimer, and the Air Force's Quest for a "Super" Stockpile

> The decision to seek or not seek international control of atomic energy, the decision to try to make or not make the hydrogen bomb, these are complex technical things, but they touch the very basis of our morality. It is a grave danger for us that these decisions are taken on the basis of facts held secret. This is not because those who contributed to the decisions or make them are lacking in wisdom; it is because wisdom itself cannot flourish and even the truth cannot be established, without the give and take of debate and criticism. The facts, the relevant facts, are of little use to an enemy, yet they are fundamental to an understanding of the issues of policy. If we are guided by fear alone, we will fail in this time of crisis. The answer to fear can't always lie in the dissipation of its cause; sometimes it lies in courage.[434]

Taken from a February 1950 radio interview with Eleanor Roosevelt, J. Robert Oppenheimer could only implicitly refer to fallout, because of the intense official secrecy surrounding the topic. Harry Truman soon prohibited any further public dissension or commentary, direct or implicit, about his recent decision to order accelerated research and development of thermonuclear weapons.[435] Prompted by discovery of the Soviet Union's development of nuclear weapons and an Air Force demand for high-yield weapons to maintain American advantage, Truman acted against the initial advice of Oppenheimer, the AEC General Advisory Committee (GAC), and the Atomic Energy commissioners by initiating a hasty effort to up the ante in the Cold War.[436] The danger of cumulative fallout was at the core of the General Advisory Committee's concerns about the dangerous escalation of the arms race brought about by the decision to pursue the hydrogen bomb.

---

[434] J. Robert Oppenheimer, 12 February 1950, radio show interview with Eleanor Roosevelt, reproduced in U.S. Atomic Energy Commission, Forward by Phillip M. Stern, *In the Matter of J. Robert Oppenheimer: Transcript of Hearing before Personnel Security Board and Texts of Principal Documents and Letters* (Cambridge: MIT Press, 1971), 962.

[435] Priscilla J. McMillan, *The Ruin of J. Robert Oppenheimer and the Birth of the Modern Arms Race* (New York: Viking, 2005), 4.

[436] The sixtieth anniversary of the end of World War Two and the Manhattan Project's successful conclusion, along with recent progress in declassification brought a tranche of new works, including those specifically about Oppenheimer and his tribulations. A reliable, well-grounded general work was Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Alfred E. Knopf, 2003. Speaking directly and effectively to many of the issues explored here was Priscilla J. McMillan, *The Ruin of J. Robert Oppenheimer and the Birth of the Modern Arms Race* (New York: Viking, 2003.) While there is little new of any note from the right on Oppenheimer, it may be helpful to consult a fairly standard example in one of their works encapsulating claims to a "dangerously slow" research effort, his alleged efforts to discourage Edward Teller from working on thermonuclear weapons, and accusations of a failure to detect Soviet tests, including at least one entirely specious claim, "By the end of 1949…[the U.S. and USSR] had exploded the same number of weapons." Earl H. Voss, *Nuclear Ambush: The Test Ban Trap* (Chicago: Henry Regnery Company, 1963), 254.

A crucially important strand of fallout's history, but one where its capacity to shape and constrain policy making was far from abundantly clear, was fallout's role in Robert Oppenheimer's 1954 show trial and purge.[437] Construction of a history of nuclear intelligence and fallout provided significant new evidence that unexpectedly problematized the useful, if dated and incomplete model of a dualistic *deus ex machina* of rabid McCarthy-era politics and the Air Force's institutional nuclear aspirations as the driving forces behind Robert Oppenheimer's expulsion from government service. While these themes long offered adequate explanatory power in describing the circumstances of his downfall, on closer examination they are too weak to adequately account for all the evidence presented in the 1954 transcript published as *In the Matter of J. Robert Oppenheimer* or in the fuller picture of this ordeal that emerged in October 2014 after subsequent declassification of the nearly complete transcript.[438] This declassification action added significant new documentary evidence to better explain how the persecution of Robert Oppenheimer came about as a result of the U.S. military's struggle with the civilian Atomic Energy Commission for primary control of decision and policy making power over the American nuclear arsenal in the early Cold War. The Air Force wanted a free hand to pursue strategic military goals in order to eclipse scientific caution about fallout.

At the root of the disagreement between the Air Force and Oppenheimer was a conflict centered on the enormous potential of thermonuclear weapons to generate fallout and the policy implications of this irresolvable problem, not his loyalty. While not the only issue, the exclusion of this basis for conflict between the Air Force and Oppenheimer disguised the sharply differing views they held of the significance of the risks posed by cumulative wartime fallout and the meaning of fallout's impact on strategic policy. This war of ideas about the military utility of

[437] "Show trial" and "purge" may initially seem rather inflammatory terms, but the evidence suggests that Oppenheimer's experiences were within the same range of circumstances as those later endured by Soviet weapon designer Andrei Sakharov in the USSR. The charges made did not represent the actual conflict at stake; the defendant was limited in the evidence as their disposal to refute them, including prohibited from mentioning words or citing documents vital to the interests of the defense; and the testimony of witnesses was manipulated and selectively released to support the government's position and decision. Arguably, the treatment of the two scientists differed substantially after the legal proceedings against them, with Oppenheimer being partially rehabilitated by Kennedy's bestowing him with the Enrico Fermi Award in 1963, while Sakharov faced years of further repression.

[438] AEC/Stern, *In the Matter of J. Robert Oppenheimer*, 1954 (ITMO); United States Department of Energy, "J. Robert Oppenheimer Personnel Hearings Transcripts," October 2014, https://www.osti.gov/opennet/hearing.jsp, (ITMO2). These two versions of the 1954 hearing transcript text are respectively cited here as AEC/Stern, *ITMO* and DOE, *ITMO2* to succinctly relate and distinguish them from each other. Los Alamos recently declassified a number of new documents related to the hearing. Totaling more than 3,000 pages, the pagination of the newly declassified and largely complete transcript was significantly different than the ~1,000 page 1954 original released shortly after the hearing. See http://blog.nuclearsecrecy.com/document-list/ .

thermonuclear weapons later saw President Dwight Eisenhower essentially turnaround and adopt Oppenheimer's views, then move beyond that position to end atmospheric testing in quest of a way to dampen the public's nuclear fears while avoiding nuclear war. Because Oppenheimer was deeply implicated in both the disputed quest for these weapons and the Air Force's highly classified intelligence program directed against the nuclear program of the Soviet Union, he represents a key social tracer of fallout's effects on policy whose narrative must be explored in depth to understand how fallout imposed an inherent limitation on the use of nuclear weapons.

Oppenheimer was best known for events at the bookends of his government service. First was the technical triumph and moral Pandora's Box opened through his service as the scientific leader of the Manhattan Project that created nuclear weapons near the end of World War Two. A decade later came the ignominy in which his career ended, stripped of his security clearance amid charges of disloyalty in a 1954 personnel security investigation and hearing by the Atomic Energy Commission (AEC). Testimony at the proceeding partially revealed a far less known side of his work, aiding the successful creation of the nuclear intelligence organization, AFOAT-1. As an Air Force consultant Oppenheimer helped develop and implement global detection systems that in vastly expanded and updated form remain the technological basis for a sophisticated nuclear intelligence system, now operated by the Air Force Technical Applications Center (AFTAC), as well as arms control agreement verification by the United States and international organizations like the International Atomic Energy Agency (IAEA) and the Comprehensive Test Ban Treaty Organization (CTBTO).[439]

While he was not as central to the development of intelligence capabilities against the weapon he invented as in its creation, Oppenheimer initially played a key role consulting with the Air Force program that developed the Atomic Energy Detection System (AEDS). The ambiguities and contradictions posed by the sudden cut-off of his participation in that research and development process, along with a recasting of his role offered in a substantially delayed AFOAT-1 unit history that represented the Air Force's coda to his assistance, suggested this nearly unexplored area of the scientist's career was an essential part of the transformation of

[439] International Atomic Energy Agency, *The Evolution of IAEA Safeguards* (Vienna: IAEA, 1998), http://www-pub.iaea.org/MTCD/Publications/PDF/NVS2_web.pdf; Preparatory Commission for the Comprehensive Test Ban Treaty Organization, "The CTBT Verification Regime: Monitoring the Earth for Nuclear Explosions" (Vienna: Preparatory Commission for the CTBTO, 2015), https://www.ctbto.org/fileadmin/user_upload/public_information/2015/Verification_Regime_final_2015_final.pdf.

fallout's narrative from a closely-held secret into a global public relations problem.[440] Until recently, the extant, but often widely scattered evidence pointed toward a substantive, if convoluted circumstantial case that placed fallout at the heart of this dispute; recent declassification of the bulk of long-withheld parts of the 1954 hearing transcript all but confirmed in plain language that fallout was the primary flashpoint for the conflict between the Air Force and Oppenheimer, which ended his distinguished career in government service.

Detection of fallout from the first Soviet nuclear test, Joe-1 in late August 1949 sparked the policy crisis and subsequent conflict between Oppenheimer and the Air Force over fallout's constraints on the military utility of thermonuclear weapons.[441] After his service on the team that assessed evidence AFOAT-1 collected to confirm that Joe-1's samples represented a Soviet nuclear test, the Air Force secretly dropped consulting with him on subsequent Russian tests and related development work. However, this action did not impede Oppenheimer's work as a consultant on other secret military projects and his advocacy as a Department of State consultant to repurpose sensitive technology he helped develop so that fallout could also serve the cause of

[440] AFOAT-1, *History of Long Range Detection, 1947-1953* (Washington, DC: Headquarters, U.S. Air Force, 1954), 33. Published just after the Oppenheimer hearing in June 1954, this document focused on what the Air Force saw as the RDB's troublesome role in bringing about an operational LRD system. Whether a draft of it was admitted as classified evidence at the hearing is uncertain. Although it appears to have been originally marked Top Secret, an additional blanked out box appears next to the marked-out "Top," superficially suggesting the redacted copy released due to the author's MDR (mandatory declassification review) filing held an initial classification as above Top Secret. The blank box may have been where the era's equivalent to what are now special access program markings were placed, which typically are wholly deleted before declassification. Regardless, some of the cited text reads like it was extracted from hearing testimony. Regarding the RDB's failure to support the Air Force proposal, "this Board, by not taking positive and timely review action in this case, is in the untenable position of hampering, or even preventing, the accomplishment of an urgent operational mission of great importance to the national security." While there are significant redactions in place that prevent a full review of the declassified text, Oppenheimer's name was carefully unmentioned at several points, whereas member names of other panels, like the Loomis panel, were published. This may have been the Air Force's attempt to suppress his role in AFOAT-1's history following the lengthy conflict to drive him from government service. In contrast, the *50 Year Commemorative History* AFTAC published in 1997 does modestly credit Oppenheimer for service on the Bush Panel that reviewed the Joe-1 findings on pages 24 and 25.
[441] The term *military utility* references the practical usefulness of a weapon. A fearsome weapon may be effective if used, but such use may be constrained by factors that include, but are not limited to, availability, cost, logistics, legality, and political considerations. Although mentioned just once in the original, heavily censored 1954 Oppenheimer hearing transcript, military utility was a key concept in an earlier, largely circumstantially argued version of this chapter that preceded the Department of Energy's October 2014 declassification of the bulk of the redacted material. The problematic nature of the military utility of thermonuclear weapons received considerably more attention in the newly available portions of the transcript, although the primary limitation impacting this, fallout, was of course never directly named during the hearing.

peace through diplomacy, which later exacerbated his fallout-related conflict with the Air Force.[442]

Chapter Two elaborated on the need to conceal fallout's use as a critical intelligence source. This was in itself more than enough justification in the eyes of the military to keep nearly the whole topic area off-limits in its first decade of dealing with fallout. Prior to the 1954 hearing this included keeping knowledge about it from those without a specific need to know even within the United States government. The increasingly public status of fallout as an official problem that grew after the 1955 release of a report on the1954 CASTLE BRAVO fallout incident failed to close a persistent gap in basic weapons effect data that led civil defense authorities to complain throughout the nineteen-fifties of being kept in the dark about information they needed in order to properly advise Americans how to protect themselves against nuclear attack.[443] Despite the Air Force's dependence on fallout and other radiation as the nation's most important source of strategic intelligence on the Soviet Union prior to the imagery the U-2 began providing in 1956, this top secret use of fallout nonetheless became the subject of testimony by several witnesses at the 1954 AEC hearing. Tellingly, fallout did not.

Conflicting Views of Fallout's Significance Precipitate Policy Crisis

The Air Force's dogged pursuit of high yield thermonuclear devices to address the targets in SAC's war plan set the service on a collision course of action with the AEC following detection of the first Soviet fission test in late summer 1949.[444] Little more than three years later while sitting on an advisory board to the Office of Defense Mobilization discussing the implications of the recent test of IVY MIKE, the first successful thermonuclear test (10.4 megatons, 1 November 1952), Lee DuBridge, whose testimony will be drawn upon shortly,

[442] Discussion later in this chapter will analyze the significance of Priscilla McMillan's discovery that Oppenheimer's clearance was first suspended by the Air Force in May 1951 in light of his testimony that he first became aware of any suspension of his clearance only in January 1954 when advised of it by a reporter.
[443] Kenneth D. Rose, *One Nation Underground: The Fallout Shelter in American Culture* (New York: New York University Press, 2001), 181-184. Although limited information on shelters began trickling out after the 1955 release of the report on CASTLE BRAVO broke the official silence on fallout's threat, it was 1959 before Eisenhower's Office of Civil and Defense Mobilization published its first widely distributed guide to shelter construction, a booklet with plans for five simple shelter designs. OCDM, *The Family Fallout Shelter*, 1959, author's collection.
[444] The conflict between the Air Force, eager to obtain thermonuclear weapons, and scientists serving as the AEC's General Advisory Committee (GAC), cautionary about weapons of unlimited power, was recounted in several of the monographs cited here. McMillan, *The Ruin of J. Robert Oppenheimer*, as well as Bird and Sherwin, *American Prometheus*, offer thorough accounts. Hewlett and Duncan, *Atomic Shield*, provided a basic review as part of the AEC's official history (369-409) that suffered because it was written with only limited access to many documents that were subsequently declassified.

reported that James R. Killian, president of Massachusetts Institute of Technology, warned him of a looming conflict that caught DuBridge completely off-guard.

> Some people in the Air Force are going to be after Oppenheimer and we've got to know about it and be ready for it.[445]

Despite his leadership in creating and managing the scientific organization that made this first test of a thermonuclear device possible, concealed behind the resulting façade of accusations impugning Oppenheimer's loyalty were sharper-edged facts about the conflict over fallout that formed the bulk of the substantive basis for the Air Force's fear of the scientist.

Robert Oppenheimer's ordeal occurred during the early Cold War phenomenon of McCarthyism, but the scientist's supposed political indiscretions proved to be more cover than cause for the Air Force's actions against him. Evidence from the hearing and other sources strongly suggested the reticence by the Oppenheimer-led General Advisory Committee (GAC) to aggressively pursue thermonuclear weapons was in large part due to the GAC's recognition that massive fallout generated by wartime use of these devices would pose a global threat. This fact was first recognized in the initial Project GABRIEL report in 1949 that sought to better define the risk this radiation represented.[446] Fallout eventually blossomed into a major limitation on the Air Force's initial Cold War strategy of massive retaliation or, as several speakers at the 1950 Ramey Air Force Base commanders conference suggested, perhaps even an eventual requirement for "preventative" attack on Russia.[447] Fallout from the mass employment of thermonuclear weapons created a fundamental risk to the attacker, as well as the rest of the planet. Chapters Four and Five will discuss those subsequent developments in fallout's problematic effect on policy and decision making, even as fallout's intelligence role expanded to include support for diplomacy. This chapter examines how Robert Oppenheimer's concerns about the risks that cumulative fallout posed problematized the Air Force's intended strategy of massive thermonuclear attack. Clumsily and with only temporary effect, the service pursued Oppenheimer as if the problem was the scientist, not their bombs.

---

445 Lee Allen DuBridge, 30 March 1983 interview by Martin J. Sherwin, in Bird and Sherwin, *American Prometheus*, 451.
446 See discussion beginning in Chapter Two, page 56 and later in this chapter, page 181.
447 Discussed briefly in Chapter Two, records of this meeting and its call for an aggressive pushback against the Soviet Union are available as Item 3 at *Special Collection: Some Key Documents on Nuclear Policy Issues, 1945-1990*, National Security Archive, http://www.gwu.edu/~nsarchiv/nukevault/special/index.htm.

Enough substantial evidence was leavened throughout the original censored transcript released shortly after the AEC's 1954 hearing to establish a circumstantial argument that the decision to permanently strip Oppenheimer of his clearance was the result of an Air Force campaign to remove him as chair of the AEC's GAC n order to silence his internal critique of the service's fallout-profligate war plan.[448] General Curtis LeMay's desire for Strategic Air Command to wield the maximum amount of tonnage on target as an opening gambit in nuclear war to limit or forestall retaliatory attacks led the Air Force to resist efforts by the AEC to better define the inherent, if still uncertain limits fallout placed on the use of nuclear weapons. The result was an extended clandestine campaign against the scientific leader of the United States nuclear weapons production complex that ended his career in government service. The result for Oppenheimer was clear; the basis for the conflicts leading to the hearing was not.

Discerning the General Advisory Committee's Advice

The conflict was far more than a disagreement over political sensitivities. It was also fundamentally about policy change necessary to address uncomfortable facts. Tracing the beginnings of the case offers a stronger argument for what Oppenheimer's downfall was about than the more publicly memorable end-game of the AEC hearing. Oppenheimer chaired the GAC, appointed by the president to advise both the executive branch and the AEC commissioners by providing scientific expertise to guide policy decisions. Its members were often referred to as an "atomic brain trust" and in 1949 were largely either past participants in the Manhattan Project or science advisers to it or other areas of applied technology during World War Two.[449] In practical terms, the GAC did set policy in some cases, either directly or because policy makers lacked expertise and so were effectively reliant on deferring to the GAC's advice. Relevant to the argument here beyond considering the question of developing the super, the

[448] First in force as the 1960 SIOP-62 (Single Integrated Operational Plan), the origin of overkill can be traced back to the immediate postwar period and the first nuclear war plan developed by the Army Air Force. Authored by General Lauris Norstad, it outlined an attack on about 200 targets in the USSR and adjoining territories it controlled. For a synopsis of SIOP history, see William Burr, ed, "The Creation of SIOP-62: More Evidence on the Origins of Overkill," National Security Archive Electronic Briefing Book No. 130 (2004), http://nsarchive.gwu.edu/NSAEBB/NSAEBB130/. For Norstad's war plan, see Alex Wellerstein, "The First Atomic Stockpile Requirements (September 1945)," (9 May 2012), http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/. War plans are almost always evolutions of past plans. Given there was little new intelligence available on targets in the Soviet Union by then, updated plans from 1950 and 1951 that are the subject of discussion in this chapter were assumed to be incremental developments of Norstad's 1945 war plan that substituted anticipated high-yield weapons then under development for the kiloton-class fission weapons of the 1945 plan.

[449] Gregg Herken, *The Winning Weapon: The Atomic Bomb in the Cold War, 1945-1950* (New York: Alfred A. Knopf, 1980), 170.

GAC provided advice on research policy, recommended plans for production growth to meet future stockpile requirements, set weapon test requirements, and evaluated test results. As the debate over thermonuclear weapons demonstrated, even when the GAC acted together and delivered an arguably persuasive case, with significant support from the AEC commissioners as with its initial recommendation against a fast-paced pursuit of thermonuclear weapons, they stood over-ruled by others in the national security hierarchy. Despite the GAC's thoughtful advice on the super, which notably omitted mention of fallout, Truman ordered not only that the AEC pursue the super with all due haste, but the silence of those who gave him contrary advice that Truman declined to observe.[450]

The Historiographical Problem of Fallout

Fallout was never the sole concern that either J. Robert Oppenheimer or the government's various entities found with nuclear weapons. However, the role of fallout as a factor in shaping national security has been quite consequentially historically elided, in part because of the lingering of continued Cold War-era classification. The October 2014 release of virtually the full transcript of the 1954 hearing confirmed the term did not appear even once in the roughly 3,000 pages of testimony to Atomic Energy Commission (AEC) personnel security board hearing that permanently withdrew Oppenheimer's clearance. Despite the hearing's capacity to discuss relevant classified topics, fallout's apparent formal excision from the Oppenheimer hearing was remarkable given the context. Prohibiting its use even in secret testimony appeared to have been at least in part a political act designed to prohibit discussion about fallout as the most significant technical problem associated with nuclear weapons.[451]

Prohibiting the term fallout significantly undercut Oppenheimer's ability to explain in detail why the GAC made its recommendation against rapid pursuit of the hydrogen bomb. Without a better understanding of fallout's historical role in turning around the military's fascination with nuclear weapons and of Oppenheimer's role in shaping the mostly secret

[450] Herken, *The Winning Weapon*, 217; Bird and Sherwin, *American Prometheus*, 429.

[451] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/. Wellerstein argued that Oppenheimer and the GAC considered there were pragmatic reasons to overcome in order to pursue the super, because "there was a strong technical reason to not rush into an H-bomb program: it wasn't clear that the bomb could be built, and preparing the materials for such a bomb would decrease the rate of producing regular fission bombs." While these were significant, they were not fatal flaws in pursuing a policy of reliance on thermonuclear weapons. They paled in significance to the problem of fallout, which was already clearly on the table as established by the AEC's 1949 initiation of Project GABRIEL to establish a limit for wartime fallout.

discussions that led to this strongly resisted result, many of the narratives and conclusions drawn about nuclear weapons and the Cold War are at a minimum incomplete. With a few, like this AEC hearing, current understandings of the contextual circumstances that led to its outcome require substantial rethinking in order to better understand the roots of the arms race in Truman's hasty, politically-driven and ultimately mistaken gut-level assumption that thermonuclear weapons would contribute to a more secure nation. Instead, the pursuit of thermonuclear weapons fundamentally undercut national security by building dependence on these problematic devices to bolster what remained an unworkable strategy in practice even as SAC prepared war plans based on these faulty premises.[452] Data collected over the next few years established the fact that the GAC's misgivings were relevant. The Air Force manipulated the AEC's personnel security process in order to silence Oppenheimer's concerns about the risks posed by the fallout from the sort of unlimited, first-strike thermonuclear warfare the service believed was required to suppress a corresponding Soviet attack in the event of war.

The centrality of fallout to the debates about Cold War strategy involved two of the early postwar era's titans, Dwight D. Eisenhower and J. Robert Oppenheimer, was a crucial factor in the careers of both as they shaped national security and research and development policies. Arguably, given the end of Oppenheimer's service and the waxing of Eisenhower's administration that followed, in the long run the 1954 hearing was a watershed event that marked the passing of who would carry the burden of worrying about fallout from the scientist to the president, although this was apparent to no one at the time.

Historians remain divided about the meaning of the new material and whether it changes how the ignoble end of this distinguished scientist's career should be understood; the only really new charge in 1954 was that he obstructed research and development of the hydrogen, or thermonuclear, bomb, an accusation made with incredibly weak evidence to support it, but with much to suggest it was a fabrication.[453] The obstruction charge was even more specious than the

---

[452] This eventuality was part of the motivation in the 1949 GAC's recommendation to proceed carefully rather than hastily with development of these weapons. This was due to the fact that the fallout from testing these devices would reveal the United States was in pursuit of thermonuclear weapons, prodding the Soviets to do likewise.

[453] Except for the obstruction charge, all other allegations made against Oppenheimer in 1954 were previously reviewed at length by the AEC commissioners in 1947, as well as previously by Army counterintelligence agents serving the Manhattan Project. Essentially a form of double jeopardy, the legal gray area of the hearing as an administrative action, and not a legal case, allowed this basic ethical and legal concern to be set aside. Even a cursory review of the evidence demonstrated the obstruction charge was politically motivated and largely without a substantive basis, a circumstance that Vannevar Bush suggested would deeply harm weapons research. See discussion on Bush's view beginning on page 210.

accompanying thrice-retold tales of old friends and associates that were newly politically inconvenient by the early nineteen-fifties; they comprised the bulk of the derogatory information recycled in 1954 from an earlier 1947 proceeding to impugn his fitness to hold a clearance.[454] Some historians argued the newly available material cemented the case that "the hearings suggest that Oppenheimer was anything but disloyal."[455] Certainly so, given much of the recently declassified material was exculpatory or even praiseworthy of Oppenheimer's efforts leading the crash program ordered by Truman to develop thermonuclear weapons. These efforts by the AEC, its GAC led by Oppenheimer during all but the last few months before the successful first test, resulted in a successful demonstration of a thermonuclear design little more than three years after Joe-1. Inclusion of the now extant material would have created a distinctly different impression of the relative weight of the evidence for and against his loyalty presented at the hearing than that presented by the 1954 version of the transcript published soon after the hearing.[456]

To the extent that the hearing was driven by McCarthyist excess, exculpatory testimony and even hard facts seemingly mattered little in the decision; the majority of the hearing board was obviously not persuaded by the material made available to the public in 2014, voting to make permanent the late December 1953 suspension of Oppenheimer's clearance ordered by Dwight Eisenhower.[457] The accusations of supposed disloyalty and obstruction both clearly fail in light of the preponderance of evidence now available, never mind that the Air Force had known of, investigated, surveilled, and yet continued to work with Oppenheimer for years prior to his ouster. Rather surprisingly, this continued even after the Air Force suspended at least part of his access to classified materials for several years before the hearing, a fact that remained surprisingly unmentioned during testimony. Previous reviews found in Oppenheimer's favor on essentially the same material basis; except for the newly added obstruction charge, none of this answers the obvious question of the timing of the ultimate pursuit of Oppenheimer or what it really was that justified the considerable costs of sidelining someone who was the preeminent manager of nuclear weapons research at the height of the Cold War.

---

454 William J. Broad, "Transcripts Kept Secret for 60 Years Bolster Defense of Oppenheimer's Loyalty," *New York Times*, 11 October 2014, http://www.nytimes.com/2014/10/12/us/transcripts-kept-secret-for-60-years-bolster-defense-of-oppenheimers-loyalty.html?_r=1.

455 Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

456 William J. Board, *New York Times*, 11 October 2014, http://www.nytimes.com/2014/10/12/us/transcripts-kept-secret-for-60-years-bolster-defense-of-oppenheimers-loyalty.html?_r=1.

457 McMillan, *The Ruin of J. Robert Oppenheimer*, 177-181. Bird and Sherwin, *American Prometheus*, 478-484.

For Dwight Eisenhower, his suspension of Oppenheimer's clearance initiated the inquiry that followed, but also served to politically insulate him from his prior enthusiasm for the scientist's ideas. The future president's initial support for Oppenheimer's efforts to develop tactical nuclear weapons while urging restraint on thermonuclear weapons as unsuitable for European defense because of their significant fallout was highlighted by the newly declassified testimony's depiction of meetings between the future president and Oppenheimer at several points.[458] The May 1953 White House visit by Oppenheimer was another potential source of political embarrassment amid the fevered howls of McCarthyism.[459] In initially taking the Air Force's side in the fallout debate, Eisenhower chose to trust AEC promises via Lewis Strauss and Edward Teller that it could soon solve the fallout problem.

Ultimately, amid growing evidence of fallout's spread in the environment, this effort to produce "clean" weapons failed, leading Eisenhower to return within five years to policy prescriptions ironically much the same as those that landed Oppenheimer in hot water. Eisenhower was pressured by the steady drip of bad news about fallout to end testing as the nineteen-fifties wore on. However, he did not suddenly undergo an epiphany about fallout late in the decade as data accumulated about it. Rather, it is more accurate to say that Eisenhower found himself returning to familiar issues that Oppenheimer discussed with him before the scientist was cast out of the inner circles of the national security state. Oppenheimer's sacrifice on the altar of political expediency should be seen in a new light as a prequel to Eisenhower's own dramatic turnaround to embrace pursuit of an end to all testing, as well as clearly, if secretly, recognizing the need to avoid thermonuclear war. Thus, it was not the accumulating weight of evidence that testing was problematic as described by the otherwise quite accurate works of Benjamin P. Greene and Campbell Craig so much as Ike's realization that data from testing confirmed Oppenheimer had been right from the beginning that fallout was a fatal defect in the military utility of thermonuclear weapons.[460]

A Remarkable Turnaround

The full version of the transcript now available provides numerous examples of key witnesses "talking around" fallout in narrative form. These provided opportunities for analysis

[458] DOE, *ITMO2*, 1644-1645, 1662-1666.
[459] See Chapter Two, 160-163, this chapter, 168-171.
[460] Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (New York: Columbia University Press, 1998); Greene, *Eisenhower, Science Advice*.

that revealed the influential role of Oppenheimer's ideas about fallout. The result is a more thorough explanation to better account for the subsequent five years of nuclear ferment in national security strategy, as well as better explaining the events leading to the hearing itself. What followed ranged from the seeming triumph of massive retaliation in the form of SAC's spectacular growth to a dramatic but largely downplayed about-face in Eisenhower's second term to effectively embrace Oppenheimer's cautions about the perils of thermonuclear war.

The remarkably short fourteen years between Joe-1 and the 1963 Limited Test Ban Treaty was historically upstaged in both speed and the stark reversal it imposed on national security policy by the even shorter turnaround between the disgrace of Oppenheimer and the policy victory of his belief that the constraints imposed by fallout served as a limit on the use of thermonuclear weapons. Accumulating data would drive Eisenhower to seek an end to fallout, not only because of the wartime threat Oppenheimer warned against, but because data showed even the far more limited threat posed by testing fallout also proved unduly risky by the government's own standards. The aggressive pushback against the USSR touted by Air Force leaders at the 1950 Ramey conference was replaced by a cautious stalemate largely shaped by the problem of fallout's undermining the military utility of the weapons they hoped to use to achieve that goal. By the end of 1958, the United States, United Kingdom, and the Soviet Union declared an informal moratorium on atmospheric testing. The key to this transformation of belief about the military utility of thermonuclear weapons and the value and prospects of war conducted with them lay almost exclusively with fallout.

The Man Who Knew Too Much

It was the Air Force whose interests Oppenheimer most directly threatened by his raising concerns about the risks posed by fallout. The breadth of his knowledge of their weapons, strategy, and planning placed him in position to act as an effective, independent critic who could serve as a counterbalance to the service's proposals. Arguably, it was the nature of the Air Force war plan, its purposeful discounting of the cumulative risk posed by fallout from any mass use of nuclear weapons, which threatened the victor as much as the vanquished, that became the primary point of controversy between the service and the physicist.

The starting place for understanding the meaning of Oppenheimer's fall remains the original 1954 version of the hearing transcript rendered as *In the Matter of J. Robert*

Oppenheimer.[461] Much of the often contrived testimony in this document should not be taken at face value, as extended passages addressing Oppenheimer's loyalty starkly demonstrate. Certainly those accusations partially or largely motivated the actions of many of those involved, as can be seen in testimony from Edward Teller, most of the Air Force witnesses, and others who portrayed their sense of deprivation and loss over the super issue in October 1949 when the GAC initially declined to engage in a crash program to develop the hydrogen bomb following detection of the first Soviet test. Once Truman ordered the thermonuclear weapon project forward in January 1950, the issue in the eyes of his critics shifted to what they saw as foot-dragging and a "failure to 'enthuse'" on Oppenheimer's part.[462]

Barton J. Bernstein fixed on the outcome, even while edging up against, but not really landing on the real issue at stake, arguing that "Oppenheimer's efforts – especially his opposition to the H-bomb – helped get him in trouble with the loyalty-security system."[463] Rich evidence of that was found in charges William Borden, the former executive director of the Congressional Joint Committee on Atomic Energy (JCAE) and an Air Force Reserve officer, made in a letter to FBI Director J. Edgar Hoover and earlier in a memo to JCAE Chair Senator Brien McMahon:

> Oppenheimer has worked tirelessly…to retard the United States H-bomb program…[America had to choose between] Oppie's team [and] the team that wants to build H-bombs."[464]

Bernstein quite unintentionally framed conventional wisdom on the hearing and what Oppenheimer's 'crime' was in much the same terms as the government did, even while maintaining a critical distance.[465] For Bernstein and many other historians, the outcome of the hearing sent a message, not about loyalty, but about the place of the scientist in the Cold War policy making. A scientist might have an opinion, but take care to express it with studied nuance.

The historical relevance of the case against Oppenheimer at the hearing must be evaluated for what it charged, what it proved, and most critically, for what it obviously chose to omit, fallout. There was extensive evidence in the hearing transcript itself pointing specifically to

---

[461] AEC/Stern, *ITMO*.
[462] Philip M. Stern w/ Collaboration of Harold P. Green, and special commentary by Lloyd K. Garrison, Chief Defense Counsel for Dr. Oppenheimer, *The Oppenheimer Case: Security on Tria*l (New York: Harper-Collins, 1969), 333.
[463] Barton J. Bernstein, "Crossing the Rubicon: A Missed Opportunity to Stop the H-Bomb?" *International Security* Vol. 14, No. 2 (Autumn 1989), 157.
[464] Ibid.
[465] Bird and Sherwin, *American Prometheus*, 548.

the Air Force's fears over the significance of linkages between Oppenheimer's involvement in the Air Force's nuclear intelligence project and what the evidence strongly suggested was his cautionary approach to fallout. Comparison between the transcript and evidence subsequently revealed demonstrated the shocking weakness of the charges the Air Force witnesses made and the surprising hardiness of the untold story of fallout as motivation for much of what was held against him. Halfway-visible, it lay embedded like a wind-swept fossil in the hearing transcript in plain sight since 1954.

Given the intense security shielding AFOAT-1 related in Chapter One, analysis of why the Air Force was willing to risk examination of so sensitive a subject as nuclear intelligence at the hearing suggested the service had something at stake even more valuable to them that Oppenheimer's criticisms also put at risk. Fallout as the primary technical issue with their primary weapon was a problem just coming into focus at the time of the hearing in the form of the CASTLE BRAVO incident after nearly a decade of denial of the significance of radiation associated with the use of nuclear weapons. Maintaining flexibility for SAC's unrestricted use of these weapons was the only thing as critical to Air Force strategy as its nuclear intelligence portfolio was in 1954. Oppenheimer's knowledge of fallout's significance, independent of the service's control, represented an existential threat to the Air Force's intentions to build a vast arsenal of thermonuclear weapons.

Borden, out of his job as executive director of the Joint Committee on Atomic Energy (JCAE) with the change in control of the Senate to the Republicans after the 1952 election, finished the opening act of the tragedy by arguing in his 1953 letter to J. Edgar Hoover "that more likely than not J. Robert Oppenheimer is an agent of the Soviet Union."[466] AEC Chair Lewis Strauss pollyannishly noted, following the ordeal facilitated in part by Borden's efforts, that Oppenheimer should have been pleased to find "[t]he charge of disloyalty was settled in his favor by the opinion of the panel."[467] Was Strauss simply unconvinced by the case made for disloyalty, even as he seemed smugly satisfied of the result upholding Oppenheimer's unfitness to hold a clearance? Was there ever a real security issue involved with Oppenheimer's politics or

466 Herken, *The Winning Weapon*, 268. If there was any veracity to such a charge, it would have put an entirely different spin on the charges the Soviets "stole" the "secret" of the bomb if its creation had originally been organized by a supposedly Communist scientist. While Eisenhower was loathe to provide another opening for Senator McCarthy's excesses, Borden's letter effectively provided a bi-partisan veneer that made the AEC's action against Oppenheimer more palatable to the White House.

467 Hacker, *Elements of Controversy*, 148-151; Lewis Strauss, *Men and Decisions* (Garden City, NY: Doubleday & Co., Inc., 1962), 277.

personal rectitude? A little, very, very little, but just enough to keep the ball rolling in a morality play Strauss and the Air Force composed to justify the hearing. As Strauss's subsequent disclaimer in favor of Oppenheimer's loyalty demonstrated, such charges were largely dismissed at the hearing, other than to point out that their persistence periodically emerged again as the largely irrational motivation referenced by many of Oppenheimer's dogged pursuers.

The critical questions raised over Oppenheimer's allegiances proved not to be his personal loyalty to the nation, but the Air Force's perception that his embrace of concern about fallout threatened their fundamental institutional interests. Thus, Borden's letter and the hearing it precipitated provided an opening for the service to revisit troublesome issues, with charges of disloyalty and obstruction of the hydrogen bomb effort effectively serving as stand-ins for what the Air Force felt could not be discussed in open testimony and, as it turned out, even in classified testimony – fallout. The service's witnesses reviewed what they claimed after the fact as his obstruction on a number of issues, including research and development of nuclear intelligence operations; his suspicious turnabout from regarding fallout generated by fission weapons as insignificant to embrace concerns about the limitations it imposed on the use of thermonuclear weapons; his proposed re-purposing of intelligence capabilities to verify arms control agreements; and his facilitation of alternative centers of national security policy advice on nuclear strategy operating outside the control of the Air Force.[468]

More Than a Show Trial

Thus, the characterization of the hearing as largely a political act, as a show trial, better accounts for significant parts of an emergent narrative that suggests the hearing served as a proxy for even more substantial strategic issues that arose from scientific conflicts engendered by the significance of fallout. A hypothesis that he was just one more victim amid rampant McCarthyism does not explain much about Oppenheimer's fate or about fundamental limits he recognized fallout imposed on the use of nuclear weapons once the entire arc of events that converged at the hearing is taken into account. It does little good to understand that the 1954 hearing was not really about loyalty if in its place are only suggestions that another group of slightly more pragmatic, yet still only partially explanatory reasons drove the affair forward.

[468] The charges made are recast here more dispassionately than the way they were construed by hostile witnesses during the trial to demonstrate the mundane basis of these accusations.

Such limited conclusions do not address all facts now known to have driven the antipathy of those seeking his ouster from government service.

The general tenor of historical insights provided by the Department of Energy's October 2014 release of a substantially complete transcript fits seeing the hearing as a political act.[469] The timing of the documented origin of the Air Force's open conflict with Oppenheimer in relation to the GAC's objections to its rush toward thermonuclear weapons, the context of his association with fallout as an intelligence resource and his unexplained severance from this relationship all point to the hearing's roots in fallout. General Roscoe C. "Bim" Wilson's envisioning of Oppenheimer as a threat to Air Force war planning in testimony, with the physicist said to be seeking to subvert or disarm the Strategic Air Command, and the panel's repeated attempts to get witnesses to elaborate on a singular phrase seemed to suggest that Oppenheimer controlled a mysteriously missing nuclear power that was both global in extent and a threat "to end life on the planet as it was currently known."[470] Adding in the enormous effort subsequently expended in an ultimately failed attempt to produce useful nuclear weapons with greatly reduced fallout, when taken together all point to the hearing as revolving around fallout as a fulcrum on which each of these issues tilted. In the course of little more than a decade after Truman ordered them made, three presidents came to understand that fusion weapons were the wartime strategic cul de sac the Oppenheimer-led GAC predicted, knowledge they possessed by his paying for it at the price of his career.

What prompted the Air Force to set in motion the events that led to the hearing, which began years before the accusations of Oppenheimer's alleged obstruction of the development of the hydrogen bomb?[471] These actions were motivated by what the Air Force grew to see as the necessity to silence Oppenheimer's forthright engagement with fallout as a strategic problem through science. Oppenheimer's raising the issue of fallout threatened to obstruct Air Force plans

---

[469] Alex Wellerstein, "Oppenheimer, Unredacted: Part I – Finding the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/09/oppenheimer-unredacted-part-i/.

[470] DOE, *ITMO2*, 507-514, 1643-1644, 1670-1671. Walter Whitman stated Oppenheimer's reservation centered on the belief that if such if a thermonuclear "weapon is really loosed in a strategic campaign, which could be on both sides, it is the end of civilization as we know it, and that the efforts must be predominantly to prevent any such thing from happening." Panel chair Gordon Gray pointedly pursued Whitman on his use of the term, "the end of civilization as we know it," because Whitman was "the third witness who has said that…" Another witness, Hartley Rowe, a director of United Fruit, bluntly restated the problem in his testimony, which strongly supported Oppenheimer's loyalty, "if you used it in retaliation, you are using it against civilization, and not against the military."

[471] DOE, *ITMO2*, 2551-2553, 2568-2569.

for unlimited thermonuclear war. In fact, this fear that wider knowledge of fallout could undermine belief the United States was prepared to use these weapons inspired both the Air Force's actions against Oppenheimer and the scientist's perhaps too-loyal for our own good permanent silence about the specifics of the foolhardy, suicidal nature of nuclear war. Conversely, understanding Oppenheimer's fall also makes clear that the origin of the persistent force structure of thousands of nuclear weapons standing for ready use to this day was constructed though the triumph of political chicanery over thoughtfully considered and rational application of science and without regard for their limited military utility.

Fallout Hopes Dashed, Absence Remains a Significant Point

The circumstances of the hearing in concert with its evident omission from topical narratives found in the original 1954 transcript suggested fallout would be addressed by eventual release of the withheld material. Given the secrecy associated with fallout in 1954, it was not surprising that the term was entirely missing from the censored transcript released shortly after the hearing concluded and cited by several generations of Cold War historians. However, it was surprising, even shocking to find that fallout remained missing as a term from more than 3,000 pages of the full transcript released in 2014.[472] This absence was strikingly implausible, except as an intentional act, although definitive proof of that remains elusive. Fallout was making headlines almost daily during the hearing because of the CASTLE BRAVO incident the month before.[473] Whatever the basis for its absence in the substantially complete transcript now available, the exclusion of the term also confirmed that important and highly relevant context for much of what was discussed in testimony by hearing witnesses was sharply limited by design. Placing fallout off limits obviously served to sharply limit discussion of its role in intelligence, where secrecy met legitimate security needs, but which was nonetheless discussed at the hearing by several witnesses. Less obvious was that this apparently purposeful omission deprived Oppenheimer of the ability to substantively defend his record by discussing its role in the basis

---

[472] Observing the term's absence, the multiple chapters of the 2014 version were searched for the terms fallout and fall-out (an alternative spelling sometimes used during that era), as was also done with the 1954 version. Fallout was not censored from the original document because the full transcript demonstrated fallout was never in it in the first place. Given the subject matter and context, this "gap" is all but certain proof fallout's absence was a matter of security policy and classification in effect at the time, not a sign of fallout's irrelevance.

[473] While often used in the text of news articles in the approximate six week period between the ill-fated test and the opening of the hearing, the term fallout was generally excluded from direct mention in headlines. Representative examples include "264 Exposed to Atom Radiation after Nuclear Blast in Pacific," *New York Times*, 12 March 1954 and "How 'Hot' Is the Air?" *New York Times*, 21 March 1954.

of his conflict with the Air Force over the previous five years. This conflict was rooted in the stark limitations fallout made apparent to Oppenheimer about the Air Force's belief that the military utility of thermonuclear weapons provided the means to inflict virtually unlimited damage on the enemy.

Despite uncertainty about the extent of any remaining classified archival record documenting the reason for fallout's absence in testimony at the Oppenheimer hearing, the seemingly tenuous evidentiary basis to argue for the centrality of these connections was strengthened by what is now known about how fallout shaped the context of the hearing. By April 1954, the Atomic Energy Commission and the Department of Defense knew that preliminary results from CASTLE BRAVO (15 megatons, 1 March 1954) confirmed findings from IVY MIKE (10 megatons, 1 November 1952) of theoretical calculations that such devices generated lethal rates of radiation exposure from prompt fallout across thousands of square miles downwind from their point of detonation.[474] The rough parameters of this threat were known to the AEC at least by the 1949 initiation of Project GABRIEL. Fallout was already perceived as a potential problem even with fission weapons, albeit an apparently tolerable one given the limited threat posed by their relatively small yields.[475] Initial concerns about fallout thus focused on the greater quantities a general nuclear war might generate. As seen with the decision to resume testing in the continental United States in Nevada, justified by the wartime emergency posed by the Korean conflict, testing was acknowledged as not without risk.[476] However, the general

[474] Prompt fallout is that which is carried by the troposphere and occurs downwind from a nuclear explosion. It can extend anywhere from immediately next to ground zero to plumes traveling hundreds of miles, yet remains capable of depositing lethal fallout levels in concentrated areas at the surface. Global fallout from the same explosion will be injected above the tropopause and remain aloft in the stratosphere for longer periods; this part of the fallout problem was little understood in 1954. The GAC was always cognizant of the Frisch and Peierls calculations for estimating fallout yield from the fission components of thermonuclear explosions, as they were the basis for the Manhattan Project's efforts. See Lillian Hoddeson, et al, *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945* (Cambridge: Cambridge University Press, 1993), 21. The theoretical basis for estimates of total fallout from the fission plus fusion reaction yield was initially uncertain and certainly unproven, but close-in cloud sampling from these two tests provided designers and analysts with rough approximation of expected levels according to yield. What remained uncertain in 1954 was the rate at which fallout returned from the stratosphere, as this would determine the longer term risks it posed distinct from the more immediately dangerous prompt fallout such weapons generated.
[475] There is little available on GABRIEL, a study to determine the limits fallout was likely to impose on the use of nuclear weapons, but such a significant research project required approval and review by the GAC, including by its chair at the time, Oppenheimer. Most of the extant materials in addition to those cited in this chapter were cited in Chapter Two, along with what follows here. One factor certainly taken into account was the fallout produced by the fission trigger, or primary stage, described in the basic Frisch-Peierls calculation, since this reaction was required to ignite the secondary or fusion stage.
[476] Hacker, *Elements of Controversy*, 40.

argument in favor of testing, despite misgivings at the AEC, was that it was a limited risk undertaken to deter the far greater risks, among other things, posed by wartime fallout.[477]

GABRIEL: Exploring Fallout's Potential as a Limit to War

In 1949, Nicholas N. Smith Jr. of the AEC's Oak Ridge Laboratory began the study known as GABRIEL. Smith's memorandum clarified he sought to not only understand fallout's qualitative and quantitative properties while documenting the types of isotopes likely to pose a threat to human health on a global scale, but to answer two fundamental questions about a specific, extensive use of nuclear weapons in war.

> How many bombs could explode in Russia before lethal or dangerous amounts of radioactivity appeared in the air over North America? Which bomb products posed the greatest threat?[478]

The first was answered by the original 60 megaton yield limit for GABRIEL, a number that must have perplexed the Air Force. Smith then argued that strontium-90, because of its twenty-six year half-life, was the most significant among the more common isotopes produced in nuclear explosions. Strontium-90's tendency to accumulate in the bone marrow suggested tracking it as a representative example made the most efficient use of scarce resources against the threat fallout posed to human health given the multitudinous mix of isotopes that fallout was composed of.

At the AEC, Oppenheimer's increasing caution about the effects of thermonuclear weapons was counterbalanced by a combination of general scientific ignorance about the effects of radiation exposure accompanied by the AEC's willingness to accommodate military expediency. Smith's lack of attention to iodine-131 as a hazard comported with Shields Warren's erroneous, widely-shared view that radio-iodine was of little consequence as a health threat, due to its short half-life, an evaluation that contributed to his acquiescence to pressure from the Pentagon to declare what became the Nevada Test Site as safe to use for atmospheric testing.[479] As director of the AEC's Division of Biology and Medicine (DBM), Warren assisted Massachusetts General Hospital in developing the first standard policy on the use of radioisotopes.

---

[477] Hewlett and Duncan, *Atomic Shield*, 535. Discussions about the need for a continental test site, i.e. within the forty-eight states, in 1949 stirred resistance to this Department of Defense goal. This was resolved by the AEC and DOD agreeing that only a "national emergency" could offset the potential risks, which Korea supplied.
[478] Hacker, *Elements of Controversy*, 181.
[479] Ibid, 40.

> In the case of iodine, the thyroid, which retains most of the radioactivity, is radioresistant. In this case, the permitted dosage may be increased by a factor of 100.[480]

This proved to be a factually incorrect statement, at odds with what was soon discovered about iodine-131. Its accumulation in the thyroid gland concentrated the effects of this alpha-emitting isotope in close proximity to the active biological processes that create various hormones; children with their accelerated hormonal systems are especially sensitive to such exposures.

For those and other reasons, fallout remains the strongest technical reason to avoid the use of nuclear weapons in war. Given what was known about SAC war plans and the level of expected post-attack cumulative fallout effects, the lack of any single document spelling out this dichotomy between thermonuclear weapons as lacking in military utility as a system versus the belief in their power to deter can be overcome by discerning what condensed as in-effect policy during the 1950s.[481] Initiation of the 1949 GABRIEL study suggested its examination of the limits fallout imposed on war either predated Joe-1 or was then formed immediately thereafter to formalize the GAC's preexisting concern over it, rather than being what the Air Force appeared to see as Oppenheimer's backdoor approach of using fallout's threat to argue the need for limiting the consequences of nuclear war. If it came before early September, it was possible that the impertinence of its basic research question about the limits of nuclear war had already aroused sufficient hostility at the Air Force to make the decision to begin distancing him from especially sensitive programs like LRD even before Joe-1 added fuel to the fire, given LeMay's views on such topics. If made after early September in response to the pressure to pursue the super brought on by Joe-1, the reaction could only have been even more inflammatory for Air Force leaders.

The President's Advisory Committee on Human Radiation Experiments (ACHRE) observed "most researchers during this period subscribed to the 'threshold' theory of risk…In the face of such widespread factual ignorance it is difficult to hold these investigators culpable for imposing risks on their subjects that were not appreciated at the time."[482] It nonetheless surprises

---

[480] Advisory Committee on Human Radiation Experiments, *The Human Radiation Experiments: Final Report of the President's Advisory Committee* (New York: Oxford University Press, 1996), 208.
[481] Richard Rhodes, *Arsenals of Folly: The Making of the Nuclear Arms Race* (New York: Knopf, 2007), 84. By 1954, SAC had "identified some 1,700 designated ground zeros" in the Soviet Union. Its plans called for weapons to be delivered against these targets by about 2,400 operationally qualified flight crews.
[482] ACHRE, *The Human Radiation Experiments*, 209.

that so little interest was shown about research on fallout as it moved through the environment during the Cold War, given the range of anticipated problems predicted for use of NTS for atmospheric testing upwind from most of the American population. Bureaucracy and secrecy were not the sole causes of apparent disinterest in the risks of fallout, but they magnified the natural tendency of policy makers and war planners to ignore disquieting or inconvenient information. Unlike Oppenheimer, however, fallout could not be shown the door so long as national security strategy remained dependent on nuclear weapons.

Fallout: A Scheme to Limit SAC? Then What?

The October 2014 declassification provided numerous examples that connected together with a largely circumstantial pre-existing case suggesting that Oppenheimer knew of and even embraced the need to minimize fallout. The newly available document also offered a clear-cut explanation of why he nonetheless cooperated with the government by taking his public silence on the specific threat posed by fallout to the grave. Paradoxically, this offers a more substantive motivation for the Air Force's dogged pursuit of the hearing at the same time it offers a far better explanation why Oppenheimer did not break his silence on the matter, despite his significant misgivings about it. Concern about fallout's ill effects representing a threat to the Air Force's strategic policy of reliance on nuclear weapons predated the issues raised by the development of thermonuclear weapons and the massive fallout that resulted from their testing – and the even more ominous risks posed by their cumulative fallout in the event of full-scale conflict.

Basic to all American war planning in the first decade of nuclear weapons was a clear determination to use them in large numbers as soon as possible after commencement of hostilities.[483] In early 1949 defense officials outlined this fundamental assumption at the foundation of American Cold War strategic planning.

> [They] wrote that the US could not allow "the slightest doubt" about American willingness "to use the bomb" in a war "to creep into Soviet minds." If that were ever to happen, the plan went on, the Kremlin "may miscalculate and start the war we are trying so hard to avert."[484]

---

[483] Alex Wellerstein, "The First Atomic Stockpile Requirements (September 1945)," (9 May 2012), http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/. Notable to recall here was General Lauris Norstad's initial 1945 outline of the Air Force's weapons requirements to attack the Soviet Union. The Air Force set minimum requirements at 123 bombs, with a maximum need of 466. Of the greater total, 204 weapons were required "For destruction of 66 cities of strategic importance…"
[484] Phillip S. Meilinger, "The Early War Plans," *Air Force Magazine*, Vol. 95, No. 12 (December 2012), http://www.airforcemag.com/MagazineArchive/Pages/2012/December%202012/1212war.aspx.

Managing public perceptions about the significance of fallout thus represented a balancing act for the U.S. military, one that co-existed with what the Pentagon saw as the need to sustain deterrence through Soviet fear of American retaliation. Before Joe-1, with only fission weapons as a consideration, the General Advisory Committee, AEC leadership, and military were all in accord on the insignificance of fallout's threat. As related in Chapter One, the initial difficulty of capturing good samples for intelligence purposes reinforced this consensus belief in the atmosphere's ability to inconsequentially dilute and disperse fallout. Thermonuclear weapons upset this groupthink in profound ways. After Joe-1 and the GAC's cautious reaction to prodding from the military about thermonuclear weapons, the Air Force sought to neutralize Oppenheimer in order to alleviate scientific criticism about its plans for use of these weapons. The service seemed to believe that the problem of fallout, like the recipe for the super itself, could be solved be means of further research or, failing that, deterrence would be fostered by ensuring the United States built an insurmountable quantitative advantage.

The Missing Fallout Problem at the Heart of the Oppenheimer Hearing

The most significant prior study suggesting the missing link role of fallout in the 1954 hearing rose into view two decades ago, but with relatively little subsequent effect due to the persistent institutional marginalization of fallout in the archive through continued classification of relevant documentation. Charles A. Ziegler and David Jacobson established that the Air Force disagreed with Oppenheimer over his critiques of their planning to develop a global nuclear intelligence capability as part of his role in the Pentagon's Research and Development Board's (RDB) review process. The transcript's revelation of Oppenheimer's place in the development of the AEDS was significant because it provided a basis to explain the antipathy against him expressed by a number of witnesses.

> The secrecy that shrouded the [nuclear] surveillance system prevented its relevance in some areas from becoming known. For example, the widely publicized 1954 Oppenheimer Hearings have been extensively analyzed in books and articles, but the degree to which Oppenheimer's role in the development of the surveillance system was partly responsible for the distrust with which he was regarded in some government circles remained unrecognized.[485]

This was a remarkable find, given that the evidence they described lay in plain sight with minimal discussion about its significance for some four decades prior to it being placed in proper

[485] Ziegler and Jacobson, *Spying without Spies*, 217.

historical context in their work. Confirmation this was more than mere coincidence or an artifact of redaction of sensitive topics yet to be declassified when the transcript was first released awaited further declassification of material excised for security reasons. Just how unrecognized the significance of Oppenheimer's conflict with the Air Force was remained evident two decades later in commentary following new disclosures found in the redacted portions of the hearing transcript.[486]

Subsequently, several groups of related archival materials cited here were declassified, establishing a solid contextual basis and circumstantial case in this account for an expansion of fallout's role in the Cold War subsequent to the era through the 1949 detection of Joe-1 covered in the Ziegler and Jacobson monograph. Events leading to the 1954 hearing otherwise suggested it was to be an inconclusive end to a bitter debate waged almost exclusively behind closed doors, until CASTLE BRAVO importunely forced the problem of fallout into the global headlines. The manner in which the investigation and hearing was conducted is best assessed by considering its goal was to suppress internal discussion and debate. AEC Chair Lewis Strauss's decision to then quickly release a heavily censored and selectively slanted version of the transcript within months of the trial may not have only have been intended to squelch public sympathy toward Oppenheimer.[487] Fallout's absence from the transcript supplied seeming proof that the hearing was not about fallout either, even as the AEC was at work preparing a report to publicly downplay its significance following CASTLE BRAVO.

The Department of Energy's October 2014 declassification drew commentary from a number of historians. Many argued anew that the newly declassified version demonstrated the testimony failed to prove he was disloyal.[488] The standard for judging fitness for any individual to hold a security clearance balanced the net value of positive and derogatory evidence against them with the necessity to protect secrets. There were few if any individuals whose contributions to national security in the nuclear field exceeded Oppenheimer's and few of its secrets he was not already privy to; revoking his clearance took an effective administrator and keenly skilled

[486] DOE, *ITMO2*, https://www.osti.gov/opennet/hearing.jsp. The more than 3,000 pages of the full transcript released in October 2014 are broken down into files of each volume rendered as searchable pdf files.
[487] McMillan, *The Ruin of J. Robert Oppenheimer*, 228-229. After the Gray Board's decision was announced, editorials in a number of influential papers denounced it, so that "Strauss quickly regretted Gray's pledge to the witnesses that their testimony would remain secret." Strauss also apparently learned through wiretaps on Oppenheimer's attorneys' telephones that they felt his own testimony portrayed their client in a bad light.
[488] William J. Broad, "Transcripts Kept Secret for 60 Years Bolster Defense of Oppenheimer's Loyalty," *New York Times*, 11 October 2014.

scientist away from an effort the Air Force claimed needed maximum effort in order to succeed. If Oppenheimer was not disloyal, as Strauss indicated he was satisfied the hearing proved, it was a net negative to sideline him in the absence of conclusive evidence to dispute his loyalty.

In reporting on the significance of the hundreds of pages of additional, newly declassified testimony, the New York Times broadly opined "that Oppenheimer opposed the hydrogen bomb project on technical and military grounds, not out of Soviet sympathies." Historians of science, among them Alex Wellerstein on his blog, nuclearsecrcy.org, weighed in.

> What was missing from the Oppenheimer hearing transcript? Did the censors remove only technical information, or much more? Were the censors themselves biased in their operation? Were the technical omissions crucial or minor?[489]

Posed against evidence that raised doubts about Oppenheimer's loyalty (and with no protection against double jeopardy on the disloyalty charges previously adjudicated in 1947 because of the nature of the proceeding), Wellerstein noted that the newly available testimony failed to resolve the questions raised by his handling of the 1943 "Chevalier incident."[490] He viewed this, the focus of the loyalty/disloyalty argument, as the central question needing resolution in the hearing record; this certainly described the proceeding's legal circumstances. Wellerstein judged the original classification of the newly released materials as driven primarily by concern about the need to veil the nature of the dispute over the "super's" design beyond what was felt strictly necessary by the AEC's team to prove Oppenheimer obstructed development of the hydrogen bomb. Such excisions seemed to require use of the VISTA study's Chapter Five in evidence, because its findings alarmed the Air Force about Oppenheimer's continuing influence on strategic policy; and some miscellaneous redactions to avoid the embarrassment or encourage

---

[489] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

[490] Bird and Sherwin, *American Prometheus*, 195-201. McMillan, *The Ruin of J. Robert Oppenheimer*, 192-193. Oppenheimer had earlier admitted to a certain impropriety for failing to immediately report his suspicious contact with Haakon Chevalier. Chevalier suggested that Oppenheimer pass information on his work to the Soviets, who were American allies at the time. Oppenheimer's failure to promptly report the incident in 1943 was the pivotal troubling factor in the Gray Board's 1954 decision, although nothing significantly new was presented on this incident previously reviewed by the AEC in 1947, when votes in his favor included both Lewis Strauss and J. Edgar Hoover. Oppenheimer did aver at the hearing that he was an "idiot" for not taking quick action to report Chevalier's proposition to Manhattan Project security officers. The context of McCarthyism suggested that the Gray Board's eager pursuit of settled old business was more about Strauss and Hoover putting political distance between their past decision amid the rehashed doubts that Oppenheimer was facing in 1954 than they were indications of significant intimations of disloyalty the Air Force forced to the surface in pursuit of Oppenheimer in hopes they would stick the second or third time around.

the frankness of witnesses.[491] Wellerstein's narrow interpretation of the motivations for the hearing presumed it was not primarily political in nature, a somewhat different take than that of most of the historians quoted in the October 2014 *New York Times* article.

More importantly and of primary interest here, marginalizing the disputes over the "super" and VISTA as largely incidental house-cleaning needed to prepare the transcript that AEC Chair Lewis Strauss ordered released soon after the hearing's conclusion overlooked the Air Force's pivotal role in the timing and thrust of the charges. This lack of focus on the military antecedents of the hearing was likewise a problem with the position of those who saw the hearing as largely part and parcel of McCarthyism.

Revisioning VISTA

Wellerstein described the other technical problem substantiated by the newly released material as Oppenheimer's role in the first prospective study of the utility of nuclear weapons in the defense of Europe in the event of a Soviet attack, Project VISTA. The general thrust of this view of VISTA was grounded in hearing testimony that focused on the Pentagon's dissatisfaction with Oppenheimer because of his promotion of tactical weapons at the expense of strategic forces, suspicions augmented by the longstanding but previously reviewed disloyalty accusations.[492] Oppenheimer was the lead author of the VISTA report's Chapter Five, arguing in a draft that the thermonuclear weapons then under development would prove unsuitable for use in Europe because, as witness Lee Allen DuBridge coyly termed it in trying to get his point across without mentioning the forbidden term "fallout," of their "radio activity."[493] By 1954, the idea that SAC should control all delivery of American nuclear weapons was clearly a dead letter. On the other hand, fallout was more relevant as an issue of controversy every day.

The problem historians faced with the complete transcript was the assumption that what was missing in the heavily redacted original would eventually be found and reconnected by means of its declassification, directly providing important new context and information about the hearing. In this case, the most important and controversial missing element in understanding the

[491] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/. Wellerstein noted AEC Chair Lewis Strauss sought to silence the sympathetic treatment Oppenheimer received in some of the press with his quick release of the original transcript shortly after the hearing ended despite representations to each witness that their testimony was to remain confidential.

[492] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

[493] DOE, *ITMO2*, 1751-1752.

Oppenheimer hearing was something that was never there in the first place, fallout. In the context in which the hearing took place, this gap – for it was a gap far more substantial than the so-called bomber and missile "gaps" that followed later in the decade – occurred in a context that was preoccupied and permeated with fallout; it was missing from the transcript through human intent, not happenchance. Like the Air Force's initial difficulties with capturing and analyzing fallout samples from global wind currents, the results of digesting the newly declassified material seemed uncertain at first, but then proved deeply revealing. Reading the traces of subtext radiating from fallout that permeated the transcript despite its apparent bureaucratic exile demonstrated that while the term was formally absent, its influence and constraints remained nearly omnipresent in the text once the subtle traces of its presence were recognized. If by suppressing the term fallout, the government believed it could halt discussion of the idea of fallout, it was mistaken.

The official record revealed no witness allowed the word fallout to pass their lips. The significance of the missing term was marked by the contrast between its treatment and the relative openness with which long range detection (LRD) was discussed at the hearing, Testimony about the latter was rather surprising in light of the intense security that otherwise shrouded the nuclear intelligence effort described in Chapter One, so openness about it stood in sharp contrast with the complete excision of fallout. While deeply buried within the Air Force, LRD as a process was openly, if cautiously mentioned at the hearing because Oppenheimer's extensive involvement in its research and development was something the AEC had little cognizance of, as related at several points, but was a point the Air Force wanted made.[494]

While both of Wellerstein's arguments provided useful insights, neither was as fully explanatory as fallout in accounting for Oppenheimer's own later, guarded assertion that the hearing represented a proxy for his conflict with the Air Force, which precipitated his downfall, a reflection that also called into question taking much of the testimony at face value in assessing its meaning and significance.[495] The goal for the Air Force was less to get at the truth in the allegations against Oppenheimer than it was to construct the myth of utilitarian nuclear weapons.

[494] See pages 224-228 later in this chapter for discussion about Oppenheimer's cognizance of the krypton-85 program.
[495] See pages 239-240 later in this chapter on what Oppenheimer earthily called "the goddamnedest thing I ever saw" – his reaction when the Air Force briefed him on what was apparently SAC's first war plan taking into account anticipated thermonuclear weapon development; tritium and VISTA simply pale in significance to that category.

Revisiting the Meaning of the VISTA Conflict

Of particular significance in demonstrating fallout's central place in the conflict between Oppenheimer and the Air Force, a newly available passage added significant context to revise a previously largely misinterpreted passage found in the 1954 transcript drawn from the 1952 VISTA report on the potential use of nuclear weapons to defend Western Europe from the Soviets. Generally, this reference to VISTA during the hearing has been taken by historians to indicate the Air Force's primary motivation in objecting to the report's recommendations was because using low yield tactical nuclear weapons for the defense of Europe would erode SAC's monopoly on control and use of nuclear weapons.[496] Wellerstein summed up this commonly encountered version of why VISTA distressed the Air Force.

> The US Air Force attempted to suppress the VISTA report, because it seemed to advocate that the Army [should move] into their turf and their budget.[497]

However, a close reading of the testimony indicated that the issue was less about preservation of SAC's control of strategic weapons than it was about how Chapter Five of the VISTA report portrayed thermonuclear weapons and their limitations.

The testimony of Lee Allan DuBridge, a former GAC member and president of the California Institute of Technology at the time of the hearing, came closest to all but explicitly naming fallout as the foundation of the conflict between Oppenheimer and the Air Force. DuBridge led the VISTA study, which CIT hosted, then traveled with Oppenheimer to Europe to brief General Eisenhower and incorporate his input before finalizing the report. Eisenhower was on his last military assignment as the top U.S. military commander in Europe before retiring. DuBridge testified that VISTA intentionally omitted commenting on their strategic use.

> Our point of view throughout the VISTA study on thermo-nuclear weapons was that we did not see that they had tactical value. We made no comment on their importance as strategic weapons.[498]

[496] McMillan, *The Ruin of J. Robert Oppenheimer*, 5. McMillan casts VISTA as something with which the Air Force "took umbrage at the notion of sharing the powerful new weapons with other services…" Bird and Sherwin, *American Prometheus*, 444-445, largely took the range of Air Force objections at face value, thus missing what linked most together, fallout as a problem.
[497] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.
[498] DOE, *ITMO2*, 1751.

Besides damning the hydrogen bomb with faint praise, which undoubtedly did not sit well with Air Force leadership, Chapter Five's larger offense was its assertion that fusion weapons possessed inherent limitations, foremost of which was fallout.

Fallout as a Problem for Europe

As a physicist, Lee DuBridge's previously redacted testimony demonstrated a detailed and nuanced view of the conflict between the Air Force and Oppenheimer. Like other witnesses, DuBridge avoided use of the term fallout, but he took pains in his testimony to describe exactly what it was about Chapter Five that irked the service so bitterly. DuBridge described David Griggs, a witness at the trial and a former Air Force Chief Scientist, as reacting "very violently" when DuBridge and I.I. Rabi met Griggs over lunch as he sought to procure their agreement that Oppenheimer obstructed development of thermonuclear weapons.[499] The redacted material that followed made it plain what was driving the Air Force to concoct the enigmatic objections to VISTA Chapter Five that surfaced in hearing testimony, while insisting that previously reviewed and cleared incidents questioning Oppenheimer's loyalty be revisited.

DuBridge acknowledged the controversial nature of a discussion in an early draft of the chapter that proposed withholding attacks on Soviet population centers in the event of a crisis in Europe if the Russians refrained from attacks on American cities. Whether from ignorance about it, astute judgment it would not be helpful before the hearing board, or was simply trying to be concise, DuBridge refrained from making the rather obvious observation that this was because it suggested the need for significant revision of the Air Force's longstanding plans for a Day Zero mass attack, a concept first documented in Lauris Norstad's 1945 immediate postwar nuclear war plan.[500] Based on fission weapons, Norstad's plan formed the basis for a revision in anticipation of thermonuclear weapons that was presented at the 1950 Ramey commanders conference, just the first stop on the road that led to the first SIOP (Single Integrated Operational Plan) nearly a decade later in 1960.[501] When John F. Kennedy took office the next year, it was conceded that "because of fallout from attack of military targets…the casualties would be many millions in

---

499 AEC/Stern, *ITMO*, 526.

500 Alex Wellerstein, "The First Atomic Stockpile Requirements (September 1945)," (9 May 2012), http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/.

501 William Burr, ed., "The Creation of SIOP-62: More Evidence on the Origins of Overkill," National Security Archive Electronic Briefing Book No. 130 (2004), http://nsarchive.gwu.edu/NSAEBB/NSAEBB130/.

number. Thus limiting attack to military targets has little practical meaning as a humanitarian measure."[502] Left unmentioned was that fallout could not be limited only to Soviet territory.

In 1951 at the front end of the planning process that led to the SIOP, the Air Force found Oppenheimer repulsed by their intentions. Thermonuclear weapons provided the means to radically increase the metrics of target destruction by simply substituting them for the fission weapons already assigned to SAC's lengthy target list. The Air Force's reconceptualization of its already ambitious war plan to incorporate the tremendously improved destructive capacity of the hydrogen bomb became the primary source of the conflict between it and the scientist.[503] What Oppenheimer was able to say about the situation at the hearing comported with, rather than detracted from, the evidence that this and the GAC's concerns about a "defect" or "technical" problem inherent with thermonuclear weapons centered on fallout. Fallout consistently provided the best, fully sufficient explanation for the guarded references the scientists and other witnesses made at the time about the nature of this conflict. Fallout remained a secret at the time, but was openly discussed in the press and then later officially unveiled to Bernard Brodie's surprise in early 1955.[504] Subsequent chapters will discuss how ending fallout became the primary motivation to end atmospheric testing. Arguments that technical production problems or SAC's desire to maintain a monopoly on delivery of nuclear weapons have a place, but they all fall under the shadow of the primary technical problem that constrained the military utility of thermonuclear weapons, the enormity of their fallout.

---

502 Rhodes, *Arsenals of Folly*, 87.

503 Alex Wellerstein, "The First Atomic Stockpile Requirements (September 1945)," (9 May 2012), http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-1945/. The argument here assumes that subsequent war plans were modifications of existing plans, which changed relatively slowly until satellites began providing extensive, regular imagery coverage to update target lists more often. Until the CIA began flying the U-2 over the USSR in 1956, target data within the Soviet Union was largely derived from intelligence and images collected by the Luftwaffe during World War Two. A significant exception to this was infrasonic and seismic data collected by AFOAT-1, but this only directly pointed toward testing grounds, not the massive weapons complexes that produced the devices tested.

504 Barry H. Steiner, *Bernard Brodie and the Foundations of American Nuclear Strategy* (Lawrence: University Press of Kansas, 1991), 313 (n59). Steiner provided some limited insight into the secrecy associated with fallout as a topic at the time of the hearing, before it was realized that the full implications of CASTLE BRAVO could no longer be hidden. "Because the fallout effects of nuclear explosions were a closely guarded secret following the first American nuclear test in 1945, it is not possible to infer from Brodie's silence on this subject that he was not aware of these effects." Perhaps not for Brodie, whose expertise was in strategic planning, but the same could not be said of Oppenheimer. In a letter to a colleague, Brodie spilled the beans on the significance of the AEC's admission of the nature of fallout in its 1955 public report on the BRAVO fallout incident. "…there was only one piece of really basic information vital to an appreciation of the strategic problems of the future that was still being withheld – that concerning 'fallout.'"

For example, consider how DuBridge identified something more basic to historical arguments than a conflict centered on SAC's efforts to reserve nuclear weapons for its own use. DuBridge made it clear he saw the root cause of the VISTA Chapter Five conflict arising from a set of effects, two quite familiar to Eisenhower, plus another effect, "radio activity," that was a threat primarily associated with thermonuclear weapons.

> We did not see these thermo-nuclear weapons being used on the battle field and we made no comment on their strategic use. May I explain this point a bit?...We were envisioning a battle in Western Europe, presumably an invasion by Russian armies….we would be forced then into a battle of the NATO armies against the Russian armies…between the Rhine and the border of the Soviet Zone.
>
> We looked at the question of atomic weapons being used on armies in that area. We felt that if a thermo-nuclear weapon was available and used on armies, that its area of destruction through blast and fire and its area of damage through radio activity would be so great that we would be destroying many civilian populations in a friendly area – Western Germany – to such a great extent that the use of such a terribly destructive weapon in Western Germany was not feasible and not desirable and would be against our interests.
>
> Therefore, we saw no tactical use for it in that kind of battle. Therefore, we made no further study of the thermo-nuclear problem in that report.[505]

DuBridge took care to differentiate between the physical and political impacts of weapon effects, explicitly delineating them based on their capacity to damage the enemy, but also implicitly between those within the realm of broadly accepted norms established in the recent world war and which were known to be acceptable to Robert Oppenheimer based on his own actions and expressed beliefs, as well as to members of the GAC that he chaired. This broke down in simplest terms as the "area of destruction through blast and fire," and an effect that represented a different, rather more liminal moral equation, an "area of damage through radio activity" whose threat remained ambiguous in the absence of better data.

DuBridge's statement made three important distinctions between the effects of these weapons. The former two, blast and fire, were well-known phenomena and occurred in both temporal and physical proximity to the target. On the other hand, "radio activity" – standing in for the forbidden *fallout* – represented a largely unknown risk that could strike anywhere. Blast and fire from thermonuclear weapons might be enormous, but they were quantifiable and localized. Damage from "radio activity" or the more specific term, fallout, was difficult to define

[505] DOE, *ITMO2*, 1751-1752.

geographically and temporally, although its harm was all but epidemiologically certain. While empirical proof of the scale of fallout's threat was yet to come, the GAC's decision to initiate GABRIEL in 1949 underlined the fact that a theoretical understanding already existed that pursuing these weapons might generate fallout sufficient to strike at nearly everyone on the planet, even those firing the weapons and their families. The distinctions DuBridge made carefully tip-toed around the barrier presented by fallout being a forbidden term by engaging directly with it as the subject matter. The censors apparently came to a similar conclusion about DuBridge's construction, even if the term itself was missing. The precision and clarity with which DuBridge offered his argument about the root of the conflict stands out vividly against the bulk of the hearing's testimony that hewed closely to the obfuscation of fallout, probably contributing to the prompt disappearance of this passage into silence for sixty years until its October 2014 declassification.

A Warning to be Silent, Whatever the Cost to Science and Security

Observing the effects of Oppenheimer's disgrace, Priscilla McMillan artfully summed up the situation for scientists after the hearing and clearance revocation by noting Oppenheimer's public warning about the negative effects of decisions made in secret that opened this chapter was the last such statement uttered by an active Q-cleared insider.[506] Oppenheimer did not breach Truman's prohibition with further commentary after the president reversed the GAC decision to not aggressively pursue the super, but McMillan observed Oppenheimer continued to irritate the Air Force on other points, by opposing rapid development of the service's unrealistic nuclear-powered bomber, what it saw as his failure to support its desired creation of a second weapons laboratory, and the Strategic Air Command's efforts to monopolize fissile material for use by its bombers. McMillan, too, emphasized SAC's objections to VISTA's emphasis on tactical fission weapons and its suggestions that fissile material be diverted to those programs from the Air Force's favored high-yield thermonuclear weapons.[507]

The omission of fallout from direct discussion at the Oppenheimer hearing revealed an intentionally deceptive process that carefully steered clear of the primary source of half a decade of conflict between Oppenheimer and the Air Force and its leading role in ending his career. As

[506] At that time, the Q-clearance was the nation's highest classification category for access to sensitive nuclear information, known officially as Restricted Data. It provided a general clearance, but access to specific information was typically handled on a "need to know" basis.
[507] McMillan, *The Ruin of J. Robert Oppenheimer*, 4-5.

in other historical contexts where formal exclusion of significant information from the available record becomes obvious once a wider body of evidence is assessed and analyzed, for example through consideration of infrapolitical cultural expressions, new traces produced by interrogating the meaning of what was absent and suppressed in the archive can provide insights that significantly expand understanding of historical events.[508] Besides the glaring absence of a key topic of known relevance and great sensitivity for national security, efforts to "talk around" classification at various points in the hearing indicated fallout nonetheless remained a significant narrative factor, despite the term's formal exclusion. Although the available evidence cannot yet conclusively settle matters in some areas, the more complete puzzle offered by the newly declassified transcript makes it possible to delineate significant new insights, to evaluate faulty assumptions so they can be opened to reassessment, and to establish working hypotheses for some of the remaining issues raised in analyzing fallout's historical importance in limiting the arms race.

Finding Fallout

Given it was at least "more likely than not" that fallout was specifically excluded as a topic of discussion at the hearing, what became known subsequently about fallout makes it possible to describe with some accuracy the significant, if apparently excluded role it nonetheless played in both the conflict and the hearing that ended Oppenheimer's government career. Much like a jigsaw puzzle of a familiar subject with a few missing pieces, the prospective image that unfolds once the majority of available parts are assembled accurately describes the general scene; illustrates the context that missing pieces must fit into; and intimates a strong suggestion of the role of factors known to be present, if not yet fully addressed by the available assembled pieces. So it was with fallout in the context of the 1954 AEC hearing, where it became clear at several points in the testimony that it was difficult to impossible to have an intelligent conversation without the option of recourse to use of the term fallout.[509]

---

[508] Robin D.G. Kelley, *Race Rebels: Culture, Politics, and the Black Working Class* (New York: Free Press, 1996), 8.

[509] AEC/Stern, *ITMO*, 448. AEC attorney Robb attempted to question Norman Ramsey about techniques used in long range detection, leading to this stultifying exchange.
Robb: Were there three fundamental techniques, Doctor?
Ramsey: The usual thing when you categorize things—if you name them, I will agree with them maybe.
Robb: I will ask a question that maybe will kind [sic] it up. Was there any technique that Dr. Oppenheimer opposed?
Ramsey: I don't know. It is on the record that at least one time he opposed development of an H-bomb.
Robb: I am talking about this long range detection?
Ramsey: I don't know of any, no, sir. There may be, but I certainly do not know it.

Given his hearty embrace of tactical and other fission weapons and with most of their other qualities being roughly equivalent in form if not in scale, Oppenheimer's misgivings about thermonuclear weapons involved something that clearly distinguished them from fission weapons – only the quantity of fallout they produced could be the distinguishing factor that famously alarmed Oppenheimer during a meeting with SAC leaders to discuss the nature and scope of its war plans.[510] While accounts of this meeting vary, it is clear that the Air Force's antipathy toward Oppenheimer significantly intensified afterwards.[511]

The qualitative differences between fallout produced by fission and fusion devices are relatively minor, with the isotopes of primary concern remaining strontium-90, iodine-131, and others of that ilk.[512] The primary physical effects of blast and fire are also quite similar except for their scope, which does not scale up proportionately. Blast obeys the inverse square law; for example, scaling up from the ten megaton yield of early hydrogen bombs to the 56 megaton yield produced by the 1961 "Tsar bomba" Soviet test produced only a modestly larger zone of obvious physical destruction.[513] Larger yields create a somewhat intensified thermal pulse, but these are brief and likewise simply extend the radius of fire danger around ground zero

---

Mr. Oppenheimer: I know this is not a classroom, but the counsel and the witness are talking about two quite distinct things and therefore they are not understanding each other.

510 Freeman Dyson's account cited elsewhere here was the most informative, but David Griggs and General Roscoe "Bim" Wilson both offered alternative versions in *ITMO2* establishing a meeting between Oppenheimer and SAC representatives brought the conflict to a head. All three agreed in portraying Oppenheimer or themselves as seeing the meeting as taking the ongoing conflict between the parties to the next level.

511 The most obvious sign of Air Force displeasure was the May 1951 suspension of Oppenheimer's clearance for access to special Air Force secrets noted by Priscilla McMillan, but Air Force Secretary Finletter and Air Chief of Staff Vandenberg also put into effect the moves that eventually forced the 1954 hearing into existence. McMillan goes into great detail on this effort which involved David Griggs, his military aide, Teddy Walkowicz, and Charles J.V. Murphy, an author and Air Force Reserve officer. Bird and Sherwin cover some of the same ground in more limited fashion, as they did not have access to Murphy's personal papers as McMillan did. Reference to the indexes in the respective monographs can provide background information too lengthy to detail here.

512 See Appendix A. Available information on the use of radioactive isotopes for intelligence purposes focused on fusion reactions is even more limited than the basic understanding of those used for detection of fission explosions. However, since every fusion reaction relies on a fission reaction to initiate its propagation, roughly the same suite of isotopes is targeted by technicians analyzing samples to describe the general characteristics of the origin device. In terms of public risk, given that these admixtures all emit the same basic alpha, beta, and gamma radiation, once again it was the quantitative difference that presented the primary, unique limitation on the use of fusion weapons.

513 Alex Wellerstein, "Nukemap," http://nuclearsecrecy.com/nukemap/. For a 10 megaton (roughly the yield of IVY MIKE) airburst on Washington, DC, the Nukemap application indicates 581 square kilometers of blast damage (> 5 pounds per square inch) from an airburst extending between Bethesda and Alexandria, while a 50 megaton blast (roughly equivalent to the Tsar bomba) extends this ring of blast destruction to 1,350 square kilometers, stretching the ring of devastation into College Park, Maryland. Thus a five-fold increase in yield brings about only a 232% increase in the blast-affected area. However, the radiation yield remains roughly 500% larger.

slightly.[514] Besides his own comment in the Council on Foreign Relations presentation that Eisenhower read in May 1953, that a quantitative issue was a foundation for Oppenheimer's dispute with the Air Force was also suggested by several oblique references to the global extent of this problem and questions from the AEC's attorneys that unsuccessfully probed for comments on the potential for a weapons effect that threatened to end the world as it was known.[515] The AEC hearing failed to get to the bottom of the latter despite the panel closely questioning several witnesses about the source of what they saw as a suspiciously repeated refrain in the materials that came to light in the October 2014 declassification.

The meaning of the masked use of the term *global* in the context of the hearing became more apparent in the later use of the term "global fallout" by the Department of Energy in reference to its division of the larger part of historical fallout deposition data into that category to distinguish it from that produced by continental testing, i.e. primarily low yield fission devices at the Nevada Test Site. 'Global fallout" was that generated from U.S. testing in the Pacific and similar Soviet testing of high-yield fusion weapons. These high-yield tests accounted for far and away the largest part of all fallout produced given the propensity of thermonuclear explosions to pump large quantities of fallout into the stratosphere.[516]

Neither blast nor fire was unique to fusion weapons, either, let alone nuclear weapons in general, which is why they are classified as supraconventional effects here. The use of blast and fire effects on civilians had already become a common feature of conventional strategic bombardment by 1945.[517] While physical destruction of the scope and scale possible with thermonuclear weapons might shock the imagination, it could not shock consciences already inured by the events of World War Two to the relatively indiscriminate practice of strategic bombing prior to Hiroshima and Nagasaki.[518] Only fallout qualified as engendering all these

---

[514] Carey Sublette, "Nuclear Weapons Frequently Asked Questions," http://nuclearweaponarchive.org/Nwfaq/Nfaq5.html#nfaq5.1.

[515] Efforts by the hearing panel to pin down the origin of such phrasing ran headlong into the fact that this was most easily explained by reference to the forbidden term, fallout, but that may have been their intent in probing the reasoning of those who used it. Given fallout's exclusion from the narrative and the fact that lawyers generally ask questions designed to elicit specific answers this suggests that the hearing board was attempting to bait witnesses into a security violation by encouraging them to use it in spite of the apparent ban on its utterance at the hearing.

[516] See Appendix D. The bulk of fallout produced during the era of atmospheric testing was derived from thermonuclear testing.

[517] Pages 17 to 19 of the introduction discussed LeMay's dim view of any limits on his wartime command prerogatives.

[518] Several works on strategic bombing are useful, most notably Stewart Halsey Ross, *Strategic Bombing by the United States in World War Two: The Myths and the Facts* (Jefferson, NC: McFarland & Co., 2003.) A thorough

areas of concern – scientific, military, and moral – among what remained secret in 1954 about nuclear weapons; there is no substantive evidence of some other mystery factor to account for these known facts about the conflict that arose between Oppenheimer and the Air Force over strategic policy. Moreover, fallout "fits" together with adjoining pieces of the nuclear puzzle in every respect. Confirmation of details may remain elusive, but not the general shape of the missing piece; fallout was at the root of the conflict between Oppenheimer's concerns, the Air Force's war plans, and thermonuclear weapons.

Because some secrets about fallout still remain from that era, evaluating its role can only be partially accomplished by utilizing familiar methods of historical analysis, although that provides a vital context to outline the known parts of fallout's narrative.[519] Within those constraints, a working set of hypotheses about what remains undocumented can be outlined by this contextual construction. Substantive parts of fallout's narrative that remain indistinct or missing can be illuminated by a process some historians of technology refer to as unpacking a metaphorical "black box" of social and material relations surrounding a technology to better describe and evaluate its cultural and social impact.[520] Setting aside metaphor, in this case there actually was a black box of secrecy intended to enclose the knowledge system that included nuclear weapons; their effects including fallout, whose significance in strategic decision making appears to have been largely elided from official history much as in the example here; and the

---

discussion of the practice's evolution in World War Two was provided by Ronald Schaffer, *Wings of Judgment: American Bombing in World War Two* (New York: Oxford University Press, 1985.) A much needed critique of the history and influence of the postwar U.S. Strategic Bombing Survey can be found in Gian P. Gentile, *How Effective Is Strategic Bombing? Lessons Learned from World War II to Kosovo* (New York: New York University Press, 2001.) While it was a controversial assessment on both American strategy and LeMay's role in it during World War Two, Michael Sherry renders vital historical background from World War Two to evaluate the Cold War that came after. Michael S. Sherry, *The Rise of American Airpower: The Creation of Armageddon* (New Haven: Yale University Press, 1987.)

519 The Air Force continues to withhold detailed fallout data derived from its Cold War intelligence operations during the era of atmospheric testing despite appeals from the scientific community. Among the research stymied by continuing classification of this data is a joint Centers for Disease Control/National Cancer Institute study on the health effects of fallout. U.S. Centers for Disease Control and National Cancer Institute, *Report on the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations*, (Washington, DC, USGPO, 2001), http://www.cdc.gov/nceh/radiation/fallout/.

520 Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: The MIT Press, 1987), 14-15. From the Introduction, 14-15, the applicability of actor-network theory to thermonuclear weapons, including the important window offered by the Oppenheimer hearing, is obvious once their fallout is considered as the means to access understanding of their influence on and social construction of national security strategy. "Pinch and Bijker also borrow from the sociology of knowledge as they recommend that scholars interested in the development of technology choose controversy as one important site of research. The controversy in question is over the truth or falsity of belief or the success or failure of technology in solving problems."

means for detecting them, which was controlled by the Air Force, but which could just as well serve diplomatic and scientific purposes as it did in meeting military and intelligence requirements.

One cannot take the 1954 Oppenheimer hearing at face value and ignore the black box of fallout sitting silently in the corner. A useful comparative example would be attempting an analysis of American involvement in Vietnam without taking into account the Pentagon Papers. While the picture that can be painted with the available evidence is not as comprehensive and documentary as Daniel Ellsworth supplied in that case, fallout's ominous presence requires unpacking the faint traces that exist of it, whatever evidentiary shortcomings may remain at the end of the day. While certainty for historians can only be found in the safe zone provided by archival evidence, the tepid reaction to the substantially complete transcript of the Oppenheimer hearing suggests the need for a working hypothesis more effective at interrogating the superficial abstractions the transcript provided in order to explain Oppenheimer's appearance before the tribunal, let alone the results.

Demonstrating how this blind spot often continues to allow fallout's history to elude historical analysis, Alex Wellerstein observed, "Early 1954 was a tricky time for hydrogen bomb classification..." but was nonetheless impressed by what was made available through the declassification. "In fact, the amount of discussion of the H-bomb's development allowed in the final transcript is rather remarkable — very little has in fact been removed on this key topic." He suggested that among this material was a "strong technical reason" Oppenheimer relied on in defense of his opposition to the hydrogen bomb. Wellerstein noted the uncertainty that it could be built and would work as intended given the enormous requirements for tritium the initial design required. Instead of that gamble, Wellerstein argued Oppenheimer believed those resources would be better devoted to the production of more fission weapons of improved designs.[521] All were accurate enough statements in and of themselves, although one problematic assessment slipped through.

> In March 1954, a second hydrogen bomb was detonated as the "Bravo test." Radioactive fallout rained down on inhabited atolls in the Marshall Islands, as

[521] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

> well as a Japanese fishing boat, making the fact of it being a thermonuclear test undeniable.[522]

In fact, any fission or fusion reaction is prone to creating fallout, depending on where it is detonated; fallout per se was not indicative of a thermonuclear device, although qualitative analysis of this debris could certainly reveal it originated from a fusion reaction. While a rather minor point, Wellerstein's statement was indicative of the gap in knowledge often encountered about the strategic significance of fallout. What differentiated the dangers associated with thermonuclear weapons from those of fission weapons was not any essential qualitative difference in their effects. The reactions involved created blast, fire, and radiation, which differ significantly in scale between fission and fusion weapons, but the threatening effects they generate are qualitatively equivalent. What is crucial to understanding the difference, in both practical and historical terms, was the quantitative difference in the risks posed by fallout from the Air Force's intended application of thermonuclear weapons, when they possessed no net advantage in military utility over fission weapons equally capable of destroying any relevant target.

Fallout, Gabriel's Horn, and the Hound of the Baskervilles

As in the classic Sherlock Holmes tale, *The Hound of the Baskervilles*, the most relevant and otherwise expected evidence <u>that went unheard</u> proved to be the most relevant evidence to explain what happened at the hearing. Besides exclusion of the term fallout at the 1954 hearing, the most significant evidence of the GAC's early recognition of fallout as a problem was its approval of Project GABRIEL. Given LeMay's rejection of limits on the conduct of strategic air warfare, such a finding inherently represented a stark limitation on his ambitious plans for a SAC force capable of delivering a swift knockout blow with hundreds of thermonuclear weapons to the Soviet Union in the event of war. The SAC 1951 war plan Oppenheimer raised objection to was most likely a generation or two removed from General Lauris Norstad's immediate postwar plan to attack more than 200 targets in the Soviet Union with then newly-proven fission bombs, but with a target list not substantially different given little more was known about targets in the Soviet Union in 1951 than six years earlier.[523]

---

[522] Alex Wellerstein, "Oppenheimer Unredacted, Part II: Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

[523] Alex Wellerstein, "The First Atomic Stockpile Requirements (September 1945)," (9 May 2012), http://blog.nuclearsecrecy.com/2012/05/09/weekly-document-the-first-atomic-stockpile-requirements-september-

Given the Pentagon's orders to the AEC to maximize fissile material production after Joe-1, it is reasonable to assume that the problematic 1951 SAC war plan was developed in anticipation of near-term availability of thermonuclear weapons, with an intent to upgrade as many of the strikes on the 1945 plan as possible to high yield weapons when they became available.[524] The 60 megaton limit GABRIEL proposed was all but certain to have sparked derisive commentary and resistance from Air Force leadership.[525] This suggests an entirely different motivation for the service's action against the scientist, one that far better fits than the seemingly incredible claims by General Roscoe "Bim" Wilson and former Air Force Chief Scientist David Griggs that one of Oppenheimer's goals was to hobble SAC.

While the exact circumstances and even the precise date of the disputatious meeting remain murky, three outcomes are known, all of which strongly suggest the conflict was about fallout. First, Oppenheimer concluded the war plan was the "goddamnedest thing" he ever saw, something that clearly went beyond the bounds of what he was known to have found morally acceptable, which up to that point was nearly every other aspect of the use of nuclear weapons.[526] Second, the Air Force's swift conclusion that it wanted Oppenheimer excluded from its primary program that involved fallout, the nuclear intelligence work done by AFOAT-1, deprived Oppenheimer of the best data available about fallout in the environment and thus prevented the AEC from adding empirical evidence to support GABRIEL's contentious thesis. Finally, GABRIEL's conclusion was later revised sharply upward, seemingly as an accommodation to the anticipated availability of high yield thermonuclear weapons and the Air Force's desires to acquire and use these weapons in considerable numbers. From 60 megatons, the final revised cumulative yield was raised to 2,000 megatons, a number that might seem profligate to many now, but which later versions of SAC's war plan easily exceeded once crystalized into the SIOP

1945/. Given the limitations of defense possible against an attacking force armed with nuclear weapons, SAC's planning assumed that the best defense was an initial offense that deprived one's opponent of further capability to attack. Assuming weapons like IVY MIKE (10 megatons) and CASTLE BRAVO (15 megatons) were used, a 60 megaton cumulative fallout limit would force the Air Force to develop a war plan based on use of little more than four to six weapons, an untenable presumption for LeMay's "no limits" offensive philosophy. This would also prevent SAC from effectively conducting such a knockout blow. There was little question about the plan's intent in 1945, issues magnified by the Air Force's intended use for thermonuclear weapons by 1951, "The primary objective for the application of the atomic bomb is manifestly the simultaneous destruction of these fifteen first priority targets." A stockpile for Norstad's "optimum" list of strikes to open such a conflict resulted in a plan that called for weapons to destroy "66 cities of strategic importance" in order to achieve the destruction of "the Russian capability to wage war."

[524] Hewlett and Duncan, *Atomic Shield*, 369-370.

[525] Hacker, *Elements of Controversy*, 181-183.

[526] See page 239 for full context of this pithy quote.

(Single Integrated Operational Plan) beginning in 1960, by then well within the capabilities of SAC to inflict.

A rough calculation showed this level of total yield coincidentally would roughly coincide with a scenario in which the Air Force changed out most fission bombs for fusion weapons in Norstad's original 1945 attack plan of more than 200 targets in the Soviet Union. Assuming a plan for a substantially similar attack on the target list with fusion weapons of 10 megatons suggests the revised total may have been arrived at by this simple substitution. Given LeMay's stance, the Air Force likely still saw this comparatively expansive cumulative yield limit of 2,000 megatons as a significant constraint that would limit the expansion of SAC given the eventual addition of thousands more targets to its war plans, even if it was a considerable increase over the original GABRIEL yield limit.[527]

In the context of Truman's order to build the super and the service's ongoing suspicions of Oppenheimer's motives, the Air Force more likely than not saw GABRIEL as an elaborate backdoor scientific argument for the GAC to limit the military's access to thermonuclear weapons. Rather strikingly, such a discussion of facts about fallout at the 1954 hearing might have gone either for or against Oppenheimer. The Air Force would have had a stronger position, one that could argue he sought to use concerns over fallout as a means to limit the acquisition of nuclear weapons, rather than the rather laughable charge that the scientist was bent on effectively disabling SAC, as General Wilson and David Griggs alleged.[528] In contrast, exploring such top secret topics to argue the details would offer Oppenheimer an opening to explain why he wanted to study fallout. Explaining the need to limit planned use of thermonuclear weapons would likely permit him to discuss the role of those concerns in motivating the GAC's resistance to rushing headlong toward thermonuclear weapons. Fallout's total exclusion from hearing testimony becomes more understandable in this light.

---

[527] William Burr, ed., "The Creation of SIOP-62: More Evidence on the Origins of Overkill," National Security Archive Electronic Briefing Book No. 130 (2004), http://nsarchive.gwu.edu/NSAEBB/NSAEBB130/.

[528] AEC/Stern, *ITMO*, 683-684, 749-751. Wilson stated, referring to Oppenheimer: "as a result of this panel and other actions that had taken place in the Committee on Atomic Energy, that I felt compelled to go to the Director of Intelligence to express my concern over what I felt was a pattern of action that was simply not helpful to national defense." Griggs was even blunter: "…there was a pattern of activities all of which involved Dr. Oppenheimer… I hope it is clear to the board. If it is not, I should like to make clear why it is that I felt upset by the references to the relative importance of the Strategic Air Command and the Air Defense Command, and to the suggestion that we, the United States, give up the Strategic Air Command…" And these were blunt instruments. Wilson could articulate no clear issue, while Griggs was inventing Oppenheimer's supposed designs on SAC's future out of whole cloth.

Bim's Tale

Much of what the hearing revealed and concealed about those hunting for Robert Oppenheimer's demise was conveyed by the testimony of one of his closest military colleagues in government service, General Roscoe Charles Wilson, who served in World War Two as director of Army Air Corps liaison to the Manhattan Project.[529] Philip M. Stern argued the purely political nature of much of the questioning was designed to encourage attack on unpopular ideas.

> …the security system permits, if indeed it does not encourage, the equating of disagreement with disloyalty…it was only natural for…Wilson, after hearing Oppenheimer express his views at a top-secret Pentagon meeting, to scurry to the Air Force Chief of Intelligence to express his doubts about Oppenheimer's allegiance to the United States.[530]

While superficially accurate, Stern's misreading of Wilson's involvement and motivations as one of anxiety over Oppenheimer's loyalty catches only a small part of the significance of Wilson's testimony – and it was one Wilson specifically denied was relevant.[531]

The date of meeting that prompted General Wilson to see General Charles Cabell, the Air Force director of intelligence, was one that he struggled to remember. It was finally pinned down by reference to a document discussing a meeting of the Atomic Energy Committee of the Research and Development Board on 18 January 1951. It does not appear to be the same as the fabled confrontation, which Freeman Dyson recalled drew Oppenheimer's earthy reflection on the nature of the war plans it discussed. Rather this meeting considered the status of various aspects of weapons development, including the status of the program on lower yield tactical weapons, in a report entitled, "Military Objectives on the Use of Atomic Energy." Wilson's description made it clear that he simply did not feel Oppenheimer's level of commitment to the idea of the super was strong as he felt was appropriate. Wilson recalled that his concerns were driven by his belief the thermonuclear project seemed to be stalled at that point.[532]

---

[529] AEC/Stern, *ITMO*, 680, 685. Wilson noted that he was verbally ordered to appear by the Air Force Chief of Staff on short notice.

[530] Philip M. Stern, with collaboration of Harold P. Green, and special commentary by Lloyd K. Garrison, Chief Defense Counsel for Dr. Oppenheimer. *The Oppenheimer Case: Security on Trial* (New York: Harper-Collins, 1969), 487. Stern does not provide a citation here, so may be referring to information contained in the transcript (AEC/Stern, *ITMO*). Stern's characterization of the precipitating meeting made it clear it was other than the one Oppenheimer described in salty language.

[531] AEC/Stern, *ITMO*, 684.

[532] Ibid, 684-694.

With further research, General Wilson's involvement in the matter of J. Robert Oppenheimer grew curiouser and curiouser – beginning from the birth of long range detection. In his own autobiography, Curtis LeMay said very little about nuclear weapons and even less about intelligence. Interestingly, Wilson was mentioned in what initially seemed to be an off-hand remark in connection with the seeming odd assignment of LeMay to head the Army Air Force's research and development command soon after the war ended. LeMay confessed.

> I didn't know much about Research and Development…I'd had a little bit of engineering education. So they gathered in a lot of folks who *did* know something about this whole program: Bim Wilson and such. And we went to work.[533]

Bim turned out to be the nickname of General Wilson, who LeMay apparently took modest pains to conceal in plain sight by using just his nickname when writing in 1965, allowing for a thoughtful crumb of recognition to be thrown to those with the need to know about the close relationship between the two generals, one well-known and the other mostly working in the shadows, but as experienced as any with the art of nuclear intelligence. In 1944, Wilson worked on a xenon-133 collection project targeted at the Germans, then helped survey the damage in Hiroshima and Nagasaki before joining the Armed Forces Special Weapons Project after the Air Force's independence in 1947, which bookended his assignment to help LeMay.[534]

General Wilson served as deputy to the commander of Armed Forces Special Weapons Project (AFSWP), first under former Manhattan Project director General Leslie Groves, then with General Kenneth Nichols.[535] In 1948, Wilson began serving on the Military Liaison Committee (MLC) and the Committee on Atomic Energy (CAE) of the Research Development Board, where he was in position to work directly alongside Oppenheimer on the CAE and in

[533] LeMay, *Mission with LeMay*, 396.
[534] Ziegler and Jacobson, *Spying without Spies*, 5-6. Discussion of the use of Xe-133 sampling against the Germans in World War Two confirmed they did not appear to be running a reactor necessary to produce plutonium-239. This technique was a crude forerunner of the use of krypton-85, demonstrating an early keenness on the part of the Army Air Force to collect fissile material production data. A recent discussion, "When did the Allies know there wasn't a German bomb?" on Alex Wellerstein's "Nuclear Secrecy" blog omitted mention of the Xe-133 project, which was the most certain evidence of the answer to that question, http://blog.nuclearsecrecy.com/2015/11/13/when-did-the-allies-know-there-wasnt-a-german-bomb/. AFSWP was the Pentagon's umbrella joint service operational research and development command for nuclear weapons.
[535] As a civilian administrator Nichols had final say within the AEC over the outcome of the Oppenheimer hearing, another indication of how the interconnections of the incestuous, cloistered world of nuclear intelligence served as evidence of access to certain compartments of knowledge that reveal a substantially different set of factors at work in the hearing than often depicted in the relevant Cold War historiography.

coordination with him on the MLC.[536] On the one hand, Wilson recalled a close, even fond working relationship with Oppenheimer, staying at his home when committee meetings happened to be in California, remarking that "He was very kind to me…"[537]

Wilson's testimony was particularly interesting for its negative contrast with the still limited documentary narrative of nuclear intelligence, which celebrated the triumph of science over bureaucratic inertia. This included the AFOAT-1 unit histories, where the official record pointed almost exclusively in the direction of a markedly successful program of research and development of appropriate LRD technology, then building the capability to reliably capture evidence of the Soviet breakthrough test in a timely manner, followed by the years-long effort to dependably capture samples describing their subsequent testing.[538] The AFOAT-1 1954 unit history was clear and succinct on this matter.

> The system now consisted of several well organized, thoroughly developed components…In brief, the Atomic Energy Detection System was remarkably effective.[539]

The exception to the generally positive reporting on AFOAT-1's work was the first of these studies, issued in June 1954. Instead of an annual, it compiled the entire previous history into one volume covering 1947 to 1953. This work depicted a struggle within the Department of Defense between a variety of organizational actors. Their leaders were frequently and repeatedly identified as the DOD hashed out what to do and the source and amounts of funding for nuclear intelligence research. A significant exception was the RDB Committee on Atomic Energy (CAE), where Oppenheimer headed the committee, but went unidentified in this narrative despite numerous references to its role in carefully evaluating various proposals.[540] The result seemed to simultaneously blame Oppenheimer for doing his job, even though the CAE was but one party among many involved in the delays the text complained of, while whitewashing his name from

---

[536] AEC/Stern, *ITMO*, 681. The MLC was the military's official point of contact and coordination within the AEC. It was the body charged with promulgating military requirements for various weapons, which underwent significant delays during this period as recalled here. Much of the litany of military complaints against the AEC and Oppenheimer voiced at the hearing centered on requirements the military itself failed to deliver to the AEC in a timely manner.
[537] AEC/Stern, *ITMO*, 682.
[538] Ziegler and Jacobson, *Spying without Spies*, AFTAC, *A 50 Year Commemorative History*, and Lehman, *Perishable Secret*, all vary in the emphasis they give to the difficulties of research and development leading to establishment of the successful long range detection network, but these works all share a similarly optimistic view of the outcome of the process with the detection of Joe-1 in September 1949.
[539] AFOAT-1, Unit History, 1954, 59-60.
[540] AFOAT-1, Unit History, 1947-1953, Chapters One, Two, and Three.

this history. The timing of its publication in relationship to the timing of the hearing was suggestive, as if catching up with events, but there was no indication that its publication was more than roughly coincidental with Oppenheimer's departure under duress.

In sharp contrast to these narratives of mostly timely, capable, and effective nuclear intelligence efforts, at the AEC hearing and much like the initial volume of AFOAT-1's unit history, Wilson testified instead to the harried sense of urgency and frustration the Air Force felt at the time about the long-range detection program, heaping much of the blame for those anxious feelings directly onto Oppenheimer. Wilson, in common with most of the Air Force's leadership, assessed that Soviet power was "vulnerable only to attack by air power." Wilson said he was concerned Oppenheimer was…

> …interested in what I call the internationalizing of atomic energy, this at a time when the United States had a monopoly, and in which many people, including myself, believed that the A-bomb in the hands of the United States with an Air Force capable of using it was probably the greatest deterrent to further Russian aggression. This was a concern.

Wilson clearly emphasized that "I am not talking about loyalty." But then he suspiciously asserted on both the issue of thermonuclear weapons and the earlier long-range detection project that Oppenheimer had "reservations made on technical grounds. They were simply not challengeable by the military…but the overall effect was to deny to the Air Force the mechanism which we felt was essential to determine when this bomb went off."[541] It was easy for the Air Force to make the leap to suspect the growing reservations about fallout Oppenheimer later expressed were, in fact, nothing less than the ultimate example of "reservations made on technical grounds…simply not challengeable by the military."

Charles Ziegler noted that Lewis Strauss blamed Oppenheimer for RDB delays in 1948 *and* 1949.[542] What Strauss was referring to in 1948 was clear with respect to fallout establishing itself as a useful intelligence method at SANDSTONE, in contrast with Oppenheimer's original view of its limitations, but 1949 was less clear other than the RDB's ill-timed recommendation to cut aerial sampling funding just as the hot samples from Joe-1 arrived.[543] Lewis Strauss also gave

---

[541] AEC/Stern, *ITMO*, 684.

[542] Charles A. Ziegler, "Waiting for Joe-1: Decisions Leading to the Detection of Russia's First Atomic Bomb Test." *Social Studies of Science* 18 (1988), 215-216 n49.

[543] Strauss may have blamed Oppenheimer for delays in 1949, because of what he later recalled as the GAC's unjustified reluctance to pursue the hydrogen bomb as part and parcel of the Oppenheimer's subversive influence. However, these came before Joe-1's detection, memory may have reversed the order with which Strauss recalled the

credence to rumors that the Soviets managed to secretly test a nuclear weapon prior to Joe-1 and that evidence about the pending Joe-1 test had eluded American intelligence. The RDB's scrutiny again fell on the AFOAT-1 program in 1949. This was as much a financial and political development as it had anything to do with Oppenheimer as chair of the RDB. Truman confidant Louis Johnson took the reins as secretary of defense in mid-1949, imposing the president's austerity budget at the Pentagon. For Strauss, a Republican, memory of who to blame fixated on Oppenheimer, likely driven by conflating Johnson's budget-cutting hatchet with Oppenheimer's efforts to better establish the justifications for allotment of scarce research funding.[544]

General Wilson Drops a Dime on Oppenheimer

General Wilson's expression of the Air Force's anxieties over the delays in LRD research and development were refuted by Oppenheimer as best he could in open session during the hearing. The physicist argued "The only ground for holding up the installation of something is doubt as to whether its development had reached the right stage for it to be effective."[545] Certainly, the RDB's pending recommendation to reassess the LRD project's research program in September 1949, swept aside in the wake of the detection of Joe-1, was rendered moot by events. The successful detection resulted in a hasty expansion of such obviously productive research, rather than the recommended contraction. Blaming Oppenheimer for the entirety of what was both a difficult research problem and a subject of intense inter-service rivalry intentionally handed off to let the RDB to decide priorities in a difficult funding environment, in General Wilson's hands instead became stronger evidence of the Air Force's psychological displacement of its problems onto Oppenheimer than it was revelation of a legitimate pattern of concern about his loyalty.

In fact, as the record showed, Oppenheimer and others serving on the RDB were critical of justifications for funding research in each of the techniques: radioactive sampling, seismic, and sonic detection. In large part, however, this was a problem created by delays following requests for guidance from the JCS and the playing out of interservice rivalries at the Pentagon even after several inquiries from the RDB on the topic, as Ziegler and Jacobson extensively

irritations. Johnson's budget cuts may also have caused some pain that was later transferred in memory to Oppenheimer for blame.

[544] Lewis Strauss, *Men and Decisions* (Garden City, NY: Doubleday & Co., Inc., 1962), 204-206, 216.

[545] AEC/Stern, *ITMO*, 951.

documented.[546] Memory of the more distant past was being conveniently refashioned to fit a configuration more useful in the present, recasting it to better serve the goal of the Air Force to provide the AEC a pretext to expel Oppenheimer.

Wilson's depiction of growing misgivings about Oppenheimer ran from LRD to the super, so disturbing him that he "felt compelled to go to the Director of Intelligence to express my concern over what I felt was a pattern of action that was simply not helpful to national defense."[547] Although Wilson did not name the DoI, at the time he was General Charles P. Cabell, who was intimately aware of AFOAT-1 and its LRD mission.[548] Given Wilson's concerns over Oppenheimer's "conservative statements" about thermonuclear weapons, his opposition to nuclear-powered aircraft based on "technical judgment," and the fact that the scientist had not initially been "enthusiastic about 2 of 3 of these [nuclear intelligence] systems or devices…some of them were exceedingly difficult to produce, and some of them were very costly…" – well, one can see how that would send any military man "to the Director of Intelligence to say that I felt I was unhappy."[549] Or perhaps not, strung together as it was with a diatribe about Russian power and the threat it posed that could only be controlled by air power. It is difficult to convey here, but the yarn read in a highly contrived manner that raised suspicions it was largely composed ex post facto to be served up whole at the 1954 hearing.

Beyond raw ideology, Wilson did offer some factual basis for his concern. Reading between the lines and deconstructing what Wilson was talking about, the transcript provided some obvious insights into the motivations of the Air Force in engaging with such a sensitive issue. The "2 of 3 of these systems" referred to a desired expansion of research in support of the seismic and sonic techniques approved by the RDB so that in Wilson's eyes "the overall effect was to deny to the Air Force the mechanism which we felt was essential to determine when this

---

546 Ziegler and Jacobson, *Spying Without Spies*, Chapter 9.
547 AEC/Stern, *ITMO*, 684.
548 General Charles Pearre Cabell obituary information, http://www.arlingtoncemetery.net/cpcabell.htm. At the 1950 Ramey AFB commanders conference, Cabell cited rather precise numbers for Soviet nuclear weapons that suggested they were derived from krypton-85 monitoring. Cabell later served as assistant director of the CIA from 1953 until 1962, when he resigned in the political fallout from the failed Bay of Pigs invasion of Cuba. Cabell's low profile was a classic fit for an intelligence officer; one example of his conception of his role was the title of the autobiography he deposited at the Air University titled, *Memoirs of an Unidentified Aide*. Charles P. Cabell, Air University, Maxwell AFB, Alabama, http://www.airpower.maxwell.af.mil/airchronicles/cc/cabell.html. Cabell later wrote an expanded personal memoir, which went unpublished for nearly three decades after his death in 1971. It then became available exclusively by contacting his son, also an Air Force General; Charles P. Cabell, *A Man Of Intelligence: Memoirs Of War, Peace, and the CIA: the Memoirs of General Charles P. Cabell* Edited by Charles A. Cabell, Jr. Brigadier General, USAF (Ret), (Boulder, CO: Impavide Publications, 1997).
549 AEC/Stern, *ITMO*, 684-685.

bomb went off. In our judgment, this was one of the critical dates, or would be at that time, for developing our national-defense policy."[550] In reality, these systems provided important, but ultimately supplementary data to the collection of aerial fallout samples. Perhaps Wilson was not cognizant analysis of the fallout samples inherently provided rather precise dating of the timing of their origin in a nuclear explosion, without a need for additional confirmatory techniques? Such ignorance seems unlikely for such an experienced and well-located officer. Perhaps Wilson, instead of meaning when, meant "where"? Both seismic and sonic techniques provided capabilities to resolve locations more precisely than aerial sampling. If one needed target information, as SAC did, *where* was a far more important question than *when*. This was yet more evidence AFOAT-1 data was also intended from the beginning to serve as targeting information in support of SAC war plans.

Wilson's testimony cited intelligence research and development that were directly tied to the use of fallout despite its source being unmentioned. Wilson's appearance on behalf of SAC's interest was another strong suggestion that the political effects of fallout posed a threat to Air Force war planning and thus played the central role in bringing about Oppenheimer's AEC hearing. Understanding fallout's influence on strategic policy and Air Force resistance to acknowledging this threat suggests a substantially more compelling case to explain the hearing, fallout's omission from it, and its outcome than what became known about the weaknesses of the allegations made against him. While the newly released statements presented no exoneration for Oppenheimer's poor judgement in several dusty, previously reviewed incidents, these portions of the transcript confirmed the otherwise complex and circumstantial case for an expanded role for fallout as a constraint on strategic planning. This improved understanding of the basis of the government's internal conflict over fallout also places its origins at the very beginning of the nineteen-fifties even before a design for a thermonuclear weapon was finalized. Establishing a theoretical basis for concern about fallout illuminated the paradoxical nature of a powerful strategic arsenal that was developed in spite of scientific advice that fallout would bar any substantial use of thermonuclear weapons, except as last gasp retaliation, a national security problem that has yet to be forthrightly explained by any president.

---

[550] AEC/Stern, *ITMO*, 684.

Breaking Faith

While LeMay's R&D assignment may have covered matters other than nuclear intelligence, Wilson's clearly did not, as the focus of his career at that point was on research and development of methods for nuclear intelligence collection.[551] In fact, LeMay's terming his work at the time as specifically with "Bim" Wilson and the "whole program" suggested he may, too, have been as exclusively focused on nuclear intelligence as Wilson obviously was at the time. Clearly LeMay was in the loop from the beginning on the project that resulted in the organization of AFOAT-1.

The long-simmering but rapidly deteriorating conflict between Oppenheimer and the Air Force also suggested an additional insight into another initiative the service helped sponsor, a second weapons design laboratory. Presuming the Air Force believed Los Alamos was thoroughly penetrated by Soviet intelligence, if Oppenheimer was as disloyal as some painted him, establishing a second lab served as, not simply as a competitor to keep Los Alamos on its toes and cozy home to Edward Teller, but as a backup in the event Los Alamos suddenly was closed because its leadership was determined to be compromised. Seemingly counterproductive in the long view of history, for the Air Force weighing its options in the middle of the McCarthy era, planning for such an event likely seemed far more comprehensible given the context and the service's obsessive belief that Oppenheimer represented a threat to national security.

LeMay: Bigger Is Always Better

The substantially complete transcript released in October 2014 also added another previously excised piece of the puzzle to the conflict between Oppenheimer and General LeMay. General Wilson revealed LeMay apparently did meet Oppenheimer face-to-face to discuss the super at some point. Wilson recalled the SAC commander was blunt, telling the scientist exactly what he needed.

> I remember his saying most vigorously that they couldn't make them too big for him.[552]

LeMay's World War Two record of ruthlessly putting maximum bomb tonnage on target was the foundation on which the Air Force's desire for the virtually unlimited yields of

[551] Ziegler and Jacobson, *Spying Without Spies*, 43-44.
[552] DOE, *ITMO2*, 2350.

thermonuclear weapons stood.[553] Previous evidence of significant Air Force dissatisfaction with Oppenheimer prior to the GAC's controversial decision after Joe-1 remained deeply buried during Ziegler and Jacobson's research, which missed subtle earlier signals of estrangement that lay fallow until the Soviet achievement and Teller and Lawrence's lobbying for the super forced it to surface.[554] Following capture and initial analysis of its samples the fall of 1949, the Air Force wanted an outside review of the Joe-1 evidence before completing its report to the president confirming that evidence analyzed by AFOAT-1 demonstrated the Soviet Union successfully tested a nuclear weapon. Vannevar Bush was tapped to chair the panel, but the Air Force also chose the other members.[555] In his testimony at the 1954 hearing, Luiz Alvarez indicated why Bush told him he was appointed as chair of the panel.

> I think the reason the President chose me is that he does not trust Dr. Oppenheimer and he wants to have someone in whom he has trust as head of this committee.[556]

Bush was returned to the stand near the end of the hearing and questioned about Alavarez's assertion. Bush recalled that Alvarez's claim was "simply not true." But he then offered up what was in retrospect early evidence of the slippery slope Oppenheimer was already on with the Air Force before Joe-1. Bush took the opportunity to ask Air Force General Nelson about the makeup of the panel.

> "But wouldn't it be more reasonable for Dr. Oppenheimer to be Chairman, since he is Chairman of the General Advisory Committee?" and he said to me something to the effect that they would prefer it the way it was. That is all there was.[557]

---

[553] LeMay, *Mission with LeMay*, 348. LeMay brought his B-29 force down from high altitude, armed it with incendiaries, and set Tokyo and other cities on fire by throwing precision bombing to the winds and simply letting fire do the job at ground level. The point was to maximize ordnance expended, rather than be too concerned about what it hit. "No bomb-bay [fuel] tanks either. Nothing but bombs in those bomb-bays. We won't need all that extra gas if we're not going to altitudes."

[554] Ziegler and Jacobson, *Spying without Spies*, 208; DOE, *ITMO2*, 3066. The authors stated that the Air Force chose the Joe-1 review panel, including Oppenheimer. Subsequent declassification of Vannevar Bush's statements was more specific, indicating recently deceased Air Chief of Staff General Hoyt Vandenberg made the selection.

[555] McMillan, *The Ruin of J. Robert Oppenheimer*, 20; AEC/Stern, *ITMO*, 787, 909-912. Luis Alvarez claimed Bush told him, "I think the reason the President chose me is that he does not trust Dr. Oppenheimer and he wants to have someone in whom he has trust as head of this committee." Interestingly, Bush sharply asserted he never said such a thing, as the committee was selected by AFOAT-1 and thus was out of his hands since it was an Air Force appointment; in fact, Bush specifically recalled he was appointed by General Vandenberg.

[556] DOE, *ITMO2*, 3050.

[557] Ibid, 3052.

Bush also flatly denied Alvarez's assertion that Oppenheimer informally acted as the chair during the panel's deliberations instead of Bush.

> …I acted as chairman. When it came to the report, we wrote that report around the table…Dr. Oppenheimer contributed throughout in a normal and perfectly proper manner.[558]

Bush's interaction was almost certainly with Major General Morris R. Nelson, who commanded AFOAT-1 from August 1949 to December 1950 during the detection of Joe-1.[559] Nelson was an obvious point of contact to facilitate work between AFOAT-1 and the long range detection evaluation panel. Tellingly, unlike Luis Alvarez, who was the only witness who identified AFOAT-1 by name perhaps because he felt comfortably on the same side of the argument as the Air Force, Bush was careful to avoid such a blatant violation of the security ground rules against identifying the unit.[560]

The dispute grew from what priority to give thermonuclear weapons development into a secret May 1951 Air Force clearance suspension for Oppenheimer. The service applied pressure for a second weapons laboratory and other signals grew that Oppenheimer understood as blocking his reappointment as chair of the GAC.[561] He further irritated the Air Force through his consulting work on Project VISTA's analysis of the potential use of tactical weapons in Europe, the air-defense oriented Summer Study, and working with the Department of State as a consultant on disarmament diplomacy.[562] Concerns raised by Air Force witnesses at the 1954 hearing suggested the Air Force's complaints on these matters formed the central motivation in bringing the AEC's case against Oppenheimer. All were at least as significant, if not obviously

---

558 DOE, *ITMO2*, 3054.
559 DOE, *ITMO2*, 3055; AFTAC, *A 50 Year Commemorative History*, 11.
560 While omitting naming Alvarez as the guilty party, AFOAT-1's revelation was duly noted by Joseph and Stewart Alsop's *Washington Post* column, "Matter of Fact," under the headline of "Operation Spill-the-Beans" (12 July 1954). They quoted I.I. Rabi, the GAC chair at the time and an Oppenheimer supporter, as ironically noting AEC Chair Louis Strauss' release of the hearing transcript was "the most wholesale disclosure of secret matter in a very long time."
561 McMillan, *The Ruin of J. Robert Oppenheimer*, 145-149.
562 Bird and Sherwin, *American Prometheus*, 445-446; McMillan, *The Ruin of J. Robert Oppenheimer*, 140-141, 150-151. A significant example beyond VISTA where Oppenheimer continued to have access to Air Force secrets despite the cancellation of at least part of his Air Force clearance was the 1952 Lincoln Laboratory Summer Study of North American air defense. Oppenheimer chaired a Department of State Disarmament Panel formed near the end of the Truman administration. Its report warned that pursuit of thermonuclear weapons was "very dangerous" policy. As Priscilla McMillan noted, the Disarmament Panel "…ventured far beyond their mandate, into the deeper waters of foreign and domestic policy." Regardless of official imprimatur, along with the ill will already afoot, the Air Force could not have been pleased that Oppenheimer was treating war itself as a problem because of concerns about nuclear weapon effects.

more so than the formal charges made against Oppenheimer.[563] In light of the charges made against Oppenheimer, it was notable that the conflicts before Joe-1 over RDB assessments of the value of Air Force research and development and those made afterwards over production difficulties and long-ago adjudicated questions about his loyalty were relatively minor in comparison with the paranoia over SAC's "disarmament" articulated clumsily by General Wilson to the carefully anonymous General Cabell, then facilitated by Air Force Secretary Thomas Finletter and Air Chief of Staff General Hoyt Vandenberg in reaction to Oppenheimer's critique of SAC war plans. Oddly, for such a supposedly direct threat to his sinecure, General LeMay's organization was all but absent from the proceedings, highlighting the spotty and disjointed nature of the evidence of Oppenheimer's wrongdoing presented against the scientist at the hearing.[564]As an analogy, in some ways the evidence presented versus the charges made was akin to trying to prove a defendant was inclined to assault based on claims about his uncharged string of supposed recent murders.

Pointing to a different danger, Bush bluntly offered up his assessment of the scientific community's reaction to the credibility of the charges made against Oppenheimer and to the legitimacy of the hearing. After a leaked document detailing the particulars of the charges was rephrased by the *New York Times* so that it even more strongly suggested his opinions got him in trouble, not his loyalty, Bush told the panel that its publication stirred reaction because many already felt the affair was a baseless political attack on Oppenheimer.[565]

> The National Academy of Sciences…and the American Physical Society…are deeply stirred. The reason…is because they feel that a professional man who rendered great service to his country, rendered service beyond almost any other

[563] The Air Force objected to outside scrutiny of its air defense capabilities because the service, whose leadership was dominated by generals who led bomber pilots, felt that it was the best judge of the resource allocation available to expand SAC versus other priorities. The service's argument was based on the limited effectiveness of air defense systems when even a handful of weapons getting through would spell disaster in a war, preferring to depend on the deterrent effect of SAC to discourage such an attack.

[564] In addition to close analysis of the original 1954 transcript, the bulk of the substantial circumstantial case constructed before release of the full declassified transcript in October 2014 made possible a more substantive argument of the 1954 hearing's meaning can be gleaned from several authoritative secondary sources. Most useful is Priscilla J. McMillan's *The Ruin of J. Robert Oppenheimer,* already extensively cited, and Kai Bird and Martin Sherwin's *American Prometheus*. McMillan's work is particularly valuable in closely following extensive evidence demonstrating the involvement of the Office of the Secretary of the Air Force , including the actions of Griggs, his military aide de camp "Teddy" Walkowicz, and Charles J.V. Murphy, an author and Air Force Reserve officer who penned an anonymous attack article on Oppenheimer in the May 1953 *Fortune* magazine.

[565] McMillan, *The Ruin of J. Robert Oppenheimer*, 218. The article, the results of James "Scotty" Reston's dogged pursuit of the case, appeared in the 13 April 1954 *New York Times*.

man, is now being pilloried and put through than ordeal because he has the temerity to express his honest opinions.[566]

The censorship of Wilson's testimony about LeMay's frank comment that implicitly referred to yield was an example of how selective Strauss was in pandering to security and public relations concerns engendered by the potential threats posed by fallout in choosing what part of the transcript was released in 1954. LeMay's comment, besides its obviously inflammatory potential and along with one other brief comment censored from Wilson's otherwise surprisingly open discussion of the Air Force's motivations regarding intelligence matters in acting against Oppenheimer, reflected the fact that LeMay was at the root of fallout's transition from a secret to a problem.[567] Strauss' decision to drop Wilson's recounting of LeMay's comment entirely removed the issue of quantity or yield from the discussion of tactical weapons and bombardment connected to the VISTA dispute, an example of how fallout was an even more sensitive topic than nuclear intelligence was at the time of the 1954 hearing.[568] Another troublesome comment for Strauss as the censor was Wilson's direct use of the term long range detection, along with his framing of Oppenheimer's dispute with the Air Force as centering on his critique of the planned LRD research program.[569] Dropping that sentence obscured much of the nuance in Wilson's subsequent discussion of the intelligence aspects of fallout.

Fallout as the Biggest Secret at the Hearing

Tellingly, the testimony of General Wilson earlier noted by Ziegler and Jacobson, along with Hans Bethe's now-declassified testimony, demonstrated that discussion of intelligence operations was not totally off-limits at the hearing, thus secrecy about that topic was not the

[566] DOE, *ITMO2*, 1981.
[567] As discussed previously, a decade later, LeMay's biography was only comfortable with mentioning General Roscoe Wilson's nickname, Bim, demonstrating the continuing sensitivity both officers treated the topic of direct ties between SAC and LRD with. The author is not aware of any previous discussion of this close relationship between the two officers in the context of the Oppenheimer hearing. SAC may have been absent from the witness list, but it was not unrepresented at the hearing.
[568] DOE, *ITMO2*, 2353. The other cut passage was a statement about General Hoyt Vandenberg's answer to a question about the power of the weapon: "When asked to state how super the Super weapon was, he stated that once the principle is proven, there is no limit to its power." Notably, although Wilson described actions that likely made a major contribution to the decision to suspend Oppenheimer's Air Force clearance in May 1951, neither Wilson nor other witnesses appear to have referenced that action. This almost certainly indicated whatever its cause and extent, Oppenheimer's suspension involved a SAP-like program that controlled his access to AFOAT-1 given other evidence and the contextual circumstances.
[569] Ibid, 2359.

fundamental cause for many of the manipulations now known in the testimony.[570] What was forbidden was uttering the term fallout. Oppenheimer was left vulnerable and largely defenseless to the charge that the GAC's objections to the hydrogen bomb were not pragmatic. Without a discussion of their proximate cause, his comments on Mrs. Roosevelt's radio show could be reduced to "moralizing" about the inevitably immoral business of war and nothing more.

Oppenheimer's own invocation of morality, as well as that of Bethe and other scientists, sometimes in reference to discussion of some variant of phrasing about thermonuclear weapons' potential to destroy the world as it was known, while undoubtedly sincere, in part also apparently represented the scientists' attempt to maneuver around being forbidden use of the term fallout. Bethe discussed his interaction with David Griggs about Griggs' beliefs that the Air Force should rely on high yield weapons in exactly the terms he would if discussing the need to limit fallout. Instead of simply doing the math to demonstrate the excess of fallout in using a single multi-megaton yield thermonuclear device to strike two targets that were most efficiently destroyed with two 100 kiloton strikes, Bethe layered in a discussion of the "moral considerations" because it was "important to not over-destroy the enemy country, but to fit the weapon in each case to the target and to attempt the best accuracy that one can on bombing so as to make a minimum of destruction compatible with gaining the objective."[571] This was at the heart of the dispute over the super, not an issue of loyalty. Bethe's implicit acknowledgment of fallout as the issue also demonstrated that the cause of Oppenheimer's plight, while not widely known because of the tight security restrictions, was clearly understood for what it was by the few with clearance to have knowledge of it.

With fallout beyond the pale for discussion, the very circumscribed manner in which the service's active, longstanding interest in limiting his influence was selectively portrayed in

---

[570] DOE, *ITMO2*, 1015-1016. Bethe's classified testimony amounted to just two pages. When asked directly about the three basic methods used for detecting nuclear explosions, he offered vague comments on two of them. Fallout was obviously one, but he managed to avoid using the term and did no more than suggest that this was the case, saying next to nothing about it, as he did similarly when asked about seismic methods. He disclaimed knowledge about sonic methods, but suggested they were worth trying. Most importantly, he pointed out that he had "no knowledge" of the funding disputes involving the RDB assessment of AFOAT-1 research priorities, because "he [Oppenheimer] was sitting on a committee of advisors, you see, reporting to the Air Force, not the Commission." A brief, off the record discussion followed, after which this part of Bethe's questioning ended. Bethe served as an AFOAT-1/AFTAC scientific advisor and was already attached to it by the time of the hearing, so this precluded any deeper probing by the AEC at the hearing and was likely the reason for the off-the record discussion that quickly concluded this portion of his testimony. AFTAC, *50 Year Commemorative History*, 29, confirmed that Bethe was a primary outside consultant in analyzing Joe-4 (400 kilotons, 12 August 1953), the first Soviet thermonuclear test, while indicating his service began some time before. The timing suggests Bethe replaced Oppenheimer in this role.
[571] Ibid, 1099.

hearing testimony, and the curious and rather fantastical allegation made by Air Force witnesses that the service believed Oppenheimer intended to somehow disarm SAC, all suggest the secrecy connected to the hearing was not primarily intended to hide an intelligence operation. Importantly, Oppenheimer's direct connection of the conflict leading to the hearing to SAC's 1951 war plan earthily described in years later to Dyson, while seemingly vague, points at those misgivings as central to the dispute, rather than the conflicts over fissile material production or nuclear intelligence research and development funding that historians previously focused upon, primarily because archival materials were available to support those far more limited conclusions. Oppenheimer saw no need to disclaim to Dyson the ridiculous and unfounded accusation that he slowed development of hydrogen bomb. The blast, fire, and limited fallout produced by fission weapons did not give Oppenheimer pause; it was also unlikely that he saw the same qualitative effects from any single thermonuclear weapon much differently. While the bomb might be problematic, the real problem Oppenheimer saw was with how SAC intended to strategically use these weapons to fight a war, leading to what he believed were unnecessary and intolerable levels of global fallout.

Whither Deterrence?

Superficially, fallout might be seen as strengthening the deterrent effect of nuclear weapons on one's opponent. On the other hand, the United States military's initial decade-long effort to conceal from public knowledge fallout's uncontainable threat suggested fear of its potential to erode deterrence. What if fallout's consequences were seen as politically influential enough to stay the hand of the president or military commanders in the event of war? That could lead to precisely the sort of doubt that might give an opponent reason to believe they could gain an advantage. Strategic Air Command planners thus sought to foster deterrence by focusing on the supraconventional effect of nuclear weapons of blast, front-loading American war strategy in the event of conflict with the goal of breaking the opponent's will to resist.[572] Should deterrence fail, SAC wanted to destroy an opponent's forces with an overwhelming reaction sufficient to destroy Russian capabilities to continue a confrontation in hopes that would forestall an attack on

[572] Rhodes, *Arsenals of Folly*, 88-90. Rhodes cited George Kistiakowsky as noting after a visit to SAC to review the SIOP late in the Eisenhower administration that even fire was disregarded in targeting criteria, with the metric of destruction being calculated solely on blast. Radiation was even further off the table. No one at SAC was worried enough about the potential for fallout created by their war plans to bother keeping track of its potential damage.

the United States.[573] It was a strategy designed to discourage Soviet contemplation of pre-emptive attack by building a massive force structure, even as SAC planners ignored the consequences of the radiation associated with its use in the event of a failure of deterrence as immaterial to the task at hand. Rather than strengthening deterrence, giving credence to the threat of fallout would build up uncertainty that undermined it. Emphasizing the supraconventional effects of nuclear weapons while suppressing anxiety over their potential fallout was designed to encourage executive branch policy makers and the public to default to thinking about these devices as simply more powerful versions of weapons already morally and politically tolerable.

Fear of the political consequences of subjective reactions to nuclear weapons became somewhat better defined, coalescing around what Nina Tannenwald termed more generally as the “nuclear taboo” – a countervailing force to the use of nuclear weapons imposed by an amorphous universal abhorrence of their nature.[574] Tannenwald noted it came in reaction to this desire of the U.S. military to treat nuclear weapons as if they were conventional ones, citing comments by three protagonists whose role will be examined shortly.

> In 1958 Lt. Gen. James Gavin, a principal promoter in the U.S. military of the development of tactical nuclear weapons, wrote, “Nuclear weapons will become conventional for several reasons, among them cost, effectiveness against enemy weapons, and ease of handling.” Indeed, during the 1950s numerous U.S. leaders fully expected that a nuclear weapon would become “just another weapon.” Secretary of State John Foster Dulles accepted “the ultimate inevitability” that tactical nuclear weapons would gain "conventional" status. Adm. Arthur Radford, chairman of the Joint Chiefs of Staff under President Dwight Eisenhower, predicted in 1956 that the use of nuclear weapons “would become accepted throughout the world just as soon as people could lay their hands upon them.”[575]

---

[573] While not stated in terms of deterrence, Norstad’s 1945 war plan certainly suggested the Army Air Force already saw pre-emption as the best strategy in nuclear war. Between two opponents similarly armed with nuclear weapons, the opening hours of such a war posed a stark “use it or lose it” challenge. The more weapons launched, the fewer left that could be effectively targeted by one’s opponent in a counterforce strike.

[574] Without a clearly established link to the threat posed by fallout, Nina Tannenwald confronted the need to explain the non-use of nuclear weapons since World War Two, attributing this to a combination of factors known as the “nuclear taboo.” Theo Farrell analyzed the applicability of Tannenwald’s thesis, arguing its substance remains credible. See Theo Farrell, “Nuclear Non-Use: Constructing a Cold War History,” *Review of International Studies* (2010), 36, 819-829. Interestingly, Farrell’s article does not include the term *fallout*, a typical sign of how alienated many in the humanities remain from pursuit of more concrete, quantifiable, and empirical evidence, an effect of the security classification that kept fallout walled off from research during and after the Cold War.

[575] Nina Tannenwald, “Stigmatizing the Bomb: Origins of the Nuclear Taboo,” *International Security*, Vol. 25, No. 4 (Spring 2005), 5.

Tannenwald's explanation for why this "conventionalization" did not occur was that "nuclear weapons have come to be defined as abhorrent and unacceptable weapons of mass destruction, with a taboo on their use…[and] that the taboo has helped to constrain resort to the use of nuclear weapons since 1945 both by reinforcing deterrence and by inducing restraint even in cases where deterrence did not operate."[576] Tannenwald defined the "nuclear taboo" as a "global norm" that she argued served as a sufficient explanation for the absence of nuclear conflict when opposition to nuclear weapons was seen as largely based on the metanarrative of political subjectivities. Tannenwald's position on nuclear deterrence generally accords with that found in much of the historiography of the arms race.

However, the concept of a "nuclear taboo" is more descriptive than explanatory and failed to specifically locate fallout as its major cause. Tannenwald described the role of fallout briefly, but only as an inspiration to movements of resistance against nuclear weapons.[577] As with the military's own preference for assigning significance to the blast and fire effects of nuclear weapons, while ignoring the empirical effects of their fallout except where it served as an invaluable intelligence source, the nuclear taboo reinforced the metanarrative of fallout as an argument over public perceptions about it rather than confronting fallout's little understood, yet potentially substantial physical risks to human health, genetics and the environment.

The Perception of Deterrence Deterred by Fallout

With its influence all but unrecognized, the nonuse of nuclear weapons conceived of by theories of deterrence was problematized by fallout. It is axiomatic that deterrent forces must to be a credible threat to be useful or, more formally, to demonstrate their military utility. Discussing the newly-released materials Alex Wellerstein pointed this out in his general assessment of the hearing, linking Oppenheimer's promotion of tactical weapons in VISTA Chapter Five to the scientist's motivations in doing so as certainly not disloyal or driven by lack of attention to national security as the Air Force witnesses implied.

> Oppenheimer wanted a nuclear arsenal that the US would feel capable of using, as opposed to a strategic arsenal that would only lead to a deterrence stalemate… [this] changed the perception that Oppenheimer was acting on purely "moral" reasons against the hydrogen bomb…because he advocated making hundreds of smaller fission bombs.[578]

---

[576] Nina Tannenwald, "Stigmatizing the Bomb," 5-6.
[577] Nina Tannenwald, "Stigmatizing the Bomb," 7, 21-22.
[578] Alex Wellerstein, "Oppenheimer, Unredacted: Part II – Reading the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/16/oppenheimer-unredacted-part-ii/.

What was missing here in terms of an explanation was what was missing from the transcript all along, fallout. Oppenheimer was not simply enthralled by the idea of tactical weapons as being more useful than high-yield ones; there were factors other than fallout at play, too, such as more flexibility in use of delivery systems and limiting collateral damage from blast and fire that also motivated his promotion of these weapons knowing he was swimming against the Air Force strategic tide.

Testimony indicated mitigating such reluctance was part of the discussion when Oppenheimer and the rest of the VISTA panel sat down with General Eisenhower to discuss Chapter Five. When Walter G. Whitman, another former GAC member and later chair of the Pentagon's Research and Development Board (RDB), described why the panel dropped consideration of including in the VISTA report recommendation of a potential announcement that the United States would not initiate nuclear war or that it would withhold strikes on urban areas, he turned the discussion toward the reason why they chose to narrow VISTA's look at alternatives to defend Europe by eliminating consideration of the use of thermonuclear weapons.

> We knew at that time, of course, that thermonuclear weapons [would be] of great magnitude… well, we felt they would find their usefulness in the strategic campaign, rather than the tactical.[579]

Before leaving for Europe to speak with Eisenhower, Whitman recalled that two of Air Force Secretary Thomas Finletter's aides made the Air Force's displeasure with the question being framed in terms of the problematic nature of strategic weapons in densely populated Europe.

> They were quite disturbed that the effect of the presentation of atomic weapons in the tactical picture would react unfavorably upon the strategic air force which – no, I will try to give you what they said – on the strategic air force and its mission to knock out Russia.[580]

The context made it clear that both the VISTA team's concerns and those of the Air Force were located at the confluence of weapon effects and their planned employment. The future president found the discussion of Chapter Five interesting and provided substantive feedback later incorporated into the VISTA final draft.[581]

[579] DOE, *ITMO2*, 1665.
[580] Ibid, 1666.
[581] Ibid, 1665.

Only fallout represented an area of controversy among weapon effects at the time, with blast and fire being old hat to Europeans, certainly not something desirable, but not out of the ordinary in terms of experience. Whitman's preface to the discussion in his testimony was quite similar in its formulation of the VISTA discussions in Europe to Lee DuBridge's testimony that named "radio activity" as the major problematic effect associated with the use of thermonuclear weapons in Europe. Whitman conclusively was not invoking blast or fire as a source of potential hesitancy, given the recent experience of World War Two when little to no restraint was shown over the problem of civilian casualties.

> I think we all reached the conclusion that anything which implied any hesitancy on the part of the United States about being willing to retaliate with the atomic bomb would be disastrous. That the enemy must have no question or no feeling that there was a question in the minds of the United States about the willingness to retaliate.[582]

Given the general insignificance typically ascribed to fallout at the time, both publicly and in secret, and the fact that blasting and burning German cities was old hat to the Americans, it was difficult to discern any factor capable of causing the Russians to believe the United States would hesitate about the use of nuclear weapons to protect its interests in Europe other than fallout. The fact that Whitman and the others worried over hesitance was among the most solid evidence that the VISTA team composed Chapter Five in its report with the findings of GABRIEL in mind and that the discussion centered on the hearing's forbidden word, fallout.

Fallout's potential to contaminate the atmosphere was the definitive concern that explained the need for the term's suppression at the hearing. Paradoxically, the fear of it serving as a restraint on wartime decisionmaking also deterred discussion of this raw reality. Fallout explained why the conscientious scientist did not leak his message into the media and continued to speak of it no more than vaguely even to friends like Dyson, although the microscopic surveillance he knew he was under would have reinforced his natural circumspection on that matter.[583] Fallout also explained how, besides the frontal assault of GABRIEL and the flanking maneuver of VISTA, Oppenheimer's stubborn pressure on the Air Force led Wilson, Griggs, Finletter and likely even the cryptically stubborn general with no limits, LeMay, to believe the scientist represented a direct threat to Air Force interests, whether or not they believed William

[582] DOE, *ITMO2*, 1663-1664.
[583] McMillan, *The Ruin of J. Robert Oppenheimer*, 9, 12, 187.

Borden's pandering assertion that "more probably than not" Oppenheimer was "acting as an agent of the Soviet Union."[584] All point to the fact that the Air Force, like Oppenheimer, saw fallout as casting doubt on the military utility of thermonuclear weapons, undermining belief they would be used. As a corrosive effect on an otherwise credible deterrent, fallout fatally compromised the high-yield war plans of SAC. While the precise circumstances of the dispute that arose at the fateful 1951 meeting between the Air Force and Oppenheimer may never be exactly known, there is little doubt the root of the dispute was in what only became publicly controversial three years later after CASTLE BRAVO.

The multiple layers of secrecy that shrouded fallout were selectively tapped in making the case against Oppenheimer, helping conceal the linkages between his positions on fallout and the nuclear intelligence program that were of greatest concern to the Air Force. For example, what little that Hans Bethe revealed about sampling techniques, General Wilson obscured.[585] Fallout was something the service wanted to talk about least of all, but it chose to discuss intelligence operations to a limited extent in the face of the direct threat they believed Oppenheimer's concerns about fallout represented to the Air Force's interests due to his persistence in calling attention to the excesses of their war plans. Thus, the subject matter experts who were designated as witnesses, like Wilson and Griggs, were careful to talk around sensitive topics needed to make a case against Oppenheimer while helping ensure a positive outcome for the Air Force by carefully guiding the discussion around fallout's constantly looming presence in the hearing.

Interestingly, despite the number of witnesses associated with the program, the issue of long-range detection was not specifically mentioned in the charges brought against Oppenheimer

---

[584] McMillan, *The Ruin of J. Robert Oppenheimer*, 11, 172, 221-222; DOE, *ITMO2*, 2850-2858. Borden left his successor on the JAEC a memo outlining his case against Oppenheimer. The conclusion was a blunt, toxic distortion even considering the full blown atmosphere of McCarthyism afoot at the time. ""Dr. Oppenheimer's influence upon atomic policy has been more harmful to the United States than even would have been the betrayal of all the military-atomic information in his possession from 1940 to the present." This statement was evidence Borden either ignored fallout or simply was not cognizant that it, and not Oppenheimer, did this with every atmospheric test by any nation. Borden's testimony that he considered Oppenheimer a spy had not been among the charges against Oppenheimer, leading to the physicist's counsel to object to the letter's introduction into evidence by the hearing panel. After the letter was read into evidence, panel chair Gordon Gray argued the panel had nothing to support Borden's allegations. This most likely was the passage Strauss later Pollyannishly referred to as happily confirming the board's finding that Oppenheimer was not disloyal, merely untrustworthy.

[585] DOE, *ITMO2,* 1015-1016. Bethe's classified testimony stands out for what seems to be his evident nervousness about what he was permitted to say in comparison to the frank and forthcoming manner in which his unclassified testimony proceeded. As both a close confidant and frequent supporter of Oppenheimer's views, he was already a vulnerable witness, but his status as effectively replacing Oppenheimer in the role of chief outside scientific consultant to AFOAT-1 suggested his care to not undermine this new and perhaps still tenuous association.

nor was it addressed in the findings of the hearing.[586] It was even more remarkable, considering the nature of the charges appeared to not directly involve these highly classified topics, that the Air Force witnesses who appeared to testify against Oppenheimer did not directly represent the Air Force's Strategic Air Command either, the supposed victim of his disloyalty, but were instead drawn from the scientific and intelligence teams closely connected to the nuclear intelligence project. Taken together, these very odd circumstances represent something considerably deeper than mere happenstance.[587] The Air Force recognized fallout was a significant problem, while hoping no one else would draw the same conclusion. Decades later, fallout is almost universally recognized as the problem of nuclear weapons that nearly everyone knows about, but the obvious fact it was the primary technical problem constraining the use of nuclear weapons remains officially unconfirmed and often overlooked in most narratives involving Cold War history.

The Fallout "Gap" in Oppenheimer's Hearing

Worry at the Pentagon about sufficient fissile material production to expand the American nuclear stockpile was an example of the technical problems Wellerstein argued motivated Oppenheimer to oppose thermonuclear weapons. Witnesses, including Edward Teller, unconvincingly asserted Oppenheimer was responsible for a reprehensible delay in the new weapon's development, suggesting the production difficulties the AEC faced before 1953 might have sinister rather than practical explanations. Despite some brief, cryptic references by Hans Bethe, General Wilson and others to the work done by AFOAT-1 as it closely tracked Soviet nuclear efforts, underlying the accusations was the implication that the United States knew little about the threat that the USSR posed, thereby justifying an expectation of superhuman efforts to expeditiously create the hydrogen bomb.[588] Production of the required fissile materials for expansion of the existing weapon stockpile and the somewhat different needs of various promising thermonuclear designs required conflicting uses of the limited reactor production time available to the AEC in the early nineteen-fifties. The AEC's own historical series noted its

[586] AEC/Stern, *ITMO*, 3-7, 999-1011.

[587] Ziegler and Jacobson, *Spying without Spies*, 168. Ziegler and Jacobson did mention General R.C. "Bim" Wilson's testimony at the 1954 hearing that placed much of the blame for delays on Oppenheimer, but attributed the remarks to General Carroll Wilson in the index, along with several other similar index entries. These were two different individuals (the other was Carroll L. Wilson), but in any case it was LeMay's old friend Bim Wilson who testified at the 1954 hearing. The confusion may have simply been inadvertent, but may also have reflected the Air Force's attempts to conceal closer ties to the case than were apparent at the time.

[588] DOE, *ITMO2*, 1015-1016.

repeated requests to the military to better define what was needed to meet military requirements in order to optimize available capacity pending construction of more reactors were largely ignored.[589] There seemed to be relatively little of substance in assertions that Oppenheimer delayed production of the new class of weapons, because the failure of the Pentagon to better define its needs was the primary factor that delayed wringing the most out of existing facilities and planning for new production capacity.[590]

The transcript's rather detailed look at the controversy over design of the super left Wellerstein understandably enthused about its credibility on technical points where witnesses were permitted to go into detail, while serving to justify the original classification decision because of these extensive references to previously classified information and restricted data, but fallout should have occurred numerous times in such passages in the testimony. Arguably, fallout has always been far and away the most significant and intractable technical problem associated with thermonuclear weapons. Fallout was a feature, rather than a bug, so its intentional absence in contemporary discussion fostered a misleading gap implying this accurately represented its relative insignificance, a notion refuted by subsequent declassifications that point toward its singular importance to the history of nuclear weapons. It is remarkable that the most important technical problem associated with the science and strategy of nuclear weapons, fallout, still remains ambiguous enough because of this intentional historical absence that its role as a technical restraint on the conduct of nuclear war can be overlooked or substantially elided by otherwise knowledgeable observers like Wellerstein. The purposeful omission of fallout by means of original classification authority in practice concealed its historical relevance in many sections of the documentary record, with the 1954 hearing transcript being the most salient example. This excision was unintentionally replicated by the methodological focus of historical

---

[589] Hewlett and Duncan, *Atomic Shield*, 62-63, 141, 145, 180-183, 369-370, 511. During Oppenheimer's time as chair of the GAC, he was involved with plans for expansion of reactor capacity in 1947, 1949 (even before Joe-1 fostered alarm over Soviet nuclear weapons), and 1952. At its most basic, the problem was that reactor configuration and production time could be optimized to produce either plutonium, the primary fissile material used to construct fission weapons, or to produce tritium, which early designs for the "super" required in large quantities. An increase in tritium production in anticipation of its use in then-unproven thermonuclear weapon designs necessitated a reduction in plutonium available to construct fission weapons.

[590] One example of wasted time and effort was the heavy water plant built at Newport, Indiana, within an hour's drive of the University of Illinois campus. The author's uncle, an engineer, participated in this project. Construction was initiated at a time before Teller and Ulam's discovery provided a viable method, so the most potentially workable early thermonuclear design anticipated a device using large quantities of liquid tritium. The Teller/Ulam principle obviated the need for such extensive facilities in 1951, leading to the mothballing of Newport. The facility was reconstructed at the end of the decade to produce and store VX nerve gas.

practice on what has proven to be an incomplete and often unfaithful archive. No official explanation of the term's exclusion from hearing testimony has yet come to light. Declassification of original narratives that clearly omitted fallout when it was obviously part and parcel of a topic serve to reproduce a mistaken impression of a far less significant Cold War role for fallout. Historians should nonetheless be aware from the example of the Oppenheimer hearing that fallout may still play a carefully hidden role in such proceedings even if the term itself is absent.

Discovering Megatons of Fallout Threatens SAC

Despite its formal exclusion from the record, analysis of the newly declassified, near-complete hearing transcript together with what is otherwise known of the basis of Oppenheimer's conflict with the Air Force demonstrated significant parts of the testimony were nonetheless shot through with implicit references to fallout. Fallout stood out because of this consistently obvious non-use when it was plainly the topic under discussion.

In contrast, the extraordinarily secret nuclear intelligence program operated by AFOAT-1 was discussed in open, if guarded terms, even while observing the forced silence about the key source for much of its intelligence, fallout; this included Luis Alvarez's direct reference naming the Top Secret unit when such linkages were either discouraged or forbidden.[591] By process of elimination, the argument here is that fallout remains the only practical explanation available to stitch together a coherent narrative to explain Air Force fears about Oppenheimer's discussion of what were effectively the potential limits thermonuclear weapons might impose on nuclear war. This was the only rational explanation for Air Force witness claims that Oppenheimer's efforts, which pointed to him placing fallout in scientific context rather than moralizing about war, constituted an attempt to somehow disarm or "give up…the Strategic Air Command."[592] There was no other credible basis for such an otherwise seemingly paranoid and unrealistic accusation against the AEC's top scientist than this was sparked by his efforts to remind the Air Force that fallout must be taken into account in formulating national security policy and war plans.

[591] AEC/Stern, *ITMO*, 801. AFOAT-1 was mentioned but once, on page 801, of the original transcript during one of the more confused passages of Luis Alvarez's often confused testimony. Its appearance may have been the result of a failure to redact it during the declassification process.
[592] DOE, *ITMO2*, 2570.

Krypton-85 Capers

One of the criticisms the Oppenheimer-chaired RDB made of the AFOAT-1 LRD research and development plan was its failure to place enough priority on "determining the rate of bomb production."[593] This was likely a reference to RDB support for the krypton-85 project, demonstrating the short-sighted nature of the Air Force's fixation on detecting the first Soviet test, without considering the next important intelligence question that would arise afterward; it was but one example of the Air Force's benefiting from Oppenheimer's foresight. Obviously, the 1954 hearing panel offered nothing to put that in context, as was the case with many other questionable assertions against Oppenheimer.

Conversely, there were episodes during the hearing indicating that Oppenheimer may have been intentionally left out of the loop with regard to the status of AFOAT-1's krypton-85 project as it expanded. If the GAC had any prior access to them, Oppenheimer and the rest of GAC were quite likely not receiving intelligence reports on Soviet plutonium production directly by mid-1951 due to the Air Force's secret action against Oppenheimer, especially given the ill will since late 1949. However, the GAC's involvement in the ongoing planning to greatly expand AEC fissile material production capacity and expand the American weapons stockpile suggested they were cognizant of the krypton-85 issue.[594] Production reactors and processing facilities needed equipment to monitor emissions of the gas to determine baseline values that Western sources added to the atmosphere. Once the program to monitor Soviet plutonium production was initiated, total data for Western production was needed to evaluate potential Soviet contributions to the atmosphere's krypton-85 load. Some stack gases released at the Hanford complex were filtered beginning in early 1948, with improved filtering installed in December 1950.[595]

However, several passages of testimony at the hearing indicated the Air Force took pains to conceal part or all of AFOAT-1's operational efforts to monitor krypton-85 from Oppenheimer and others at the AEC. In discussing estimates of the pace of the Soviet nuclear program and the advantages spying produced for the United States nuclear program, Oppenheimer seemed to indicate that perhaps only the Murray Hill Area (MHA) project and

---

[593] Zeigler and Jacobson, *Spying without Spies*, 163-166.

[594] See Appendix A for detailed explanation of how krypton-85 made possible monitoring of Soviet plutonium-239 production.

[595] Washington State Department of Health, "The Release of Radioactive Material from Hanford, 1944-1972," http://www.doh.wa.gov/hanford/publications/history/release.html. The extent and effectiveness of filtering and the dates it went into use at U.S. plutonium production reactors varied widely according to oral histories of Hanford rad safe workers involved in GREEN RUN.

some other limited data were available to base estimates upon when he spoke of only "raw material" as a source of intelligence on the Soviet stockpile in one passage.[596]

> …our reliance on what the Russians could or could not do was based on primarily the supplies of material which I felt would be available to them, that is raw material…[597]

The discussion was ambiguous enough that he may have been speaking of fissile material as the "raw" material from which bombs were made, despite the complex process needed to produce it.

Moreover, like fallout, krypton-85 was not mentioned in the transcripts, so the sparse evidence of it must also be teased out from between the lines.[598] Interestingly, one of the two pages specifically known to be still missing in the recent declassification was noted on the cover of that section of the October 2014 release. It was a page that followed the above quote, page 572. A single comment by Oppenheimer from it was preserved and declassified, but the remainder of this page remains suppressed, suggesting the continuing sensitive nature of this particular topic.[599] The single sentence by Oppenheimer was located elsewhere in the October 2014 release in a chapter comprised of short redactions excised as fragments from passages published in the 1954 version. After describing how the postwar division of Europe provided the Soviet Union with access to stocks of relatively high grade uranium ore, Oppenheimer seemed to rule out his possessing information with the accuracy made possible by the krypton-85 technique when he was asked if it was possible to provide an estimate of the threat posed by the Soviet Union's nuclear forces.

> It was not conceivable; even today nobody knows how many bombs they have.[600]

---

596 Ziegler and Jacobson, *Spying without Spies*, 21-33. The Murray Hill Area project sought to secretly monopolize, in cooperation with the British, world production and trade of high grade uranium ore in order to slow Soviet efforts to produce nuclear weapons.

597 DOE, *ITMO2*, 571.

598 The effort to track Soviet plutonium inventories via monitoring of krypton-85 was well underway by the hearing date as part of a joint effort with the British that ramped up after the 1951 memo documenting the basic accuracy of the method.

599 Or perhaps not. Alec Wellerstein recalled the tortured, seemingly happenstance declassification odyssey of the October 2014 release here, "Oppenheimer Unredacted, Part 1: Finding the Lost Transcripts," http://blog.nuclearsecrecy.com/2015/01/09/oppenheimer-unredacted-part-i/. It may be that the missing remainder of page 572 is an artifact of this often historically inconclusive process and was not intentionally held as requiring continued classification. This page and page 585, at the end of General Leslie Groves' testimony, appear to be the only parts of the transcript that remain classified.

600 DOE, *ITMO2*, 572. Quote was preceded by the words "get out the uranium." The page was noted as missing on cover at: http://www.osti.gov/includes/opennet/includes/Oppenheimer%20hearings/Vol%20IV%20Oppenheimer.pdf, but this single statement from it was available on page 14 of the "Record of Deletions":

Oppenheimer's statement suggested he was not cognizant of the extent and capabilities of AFOAT-1's krypton-85 sampling program or at best possessed only limited information about it. While it likely could not produce exact estimates of the number of weapons the Soviet had available, the estimated accuracy of the technique to within five percent for Russian plutonium production suggested that Oppenheimer was outside the compartment cognizant of Willard Libby's breakthrough in its use.[601]

Libby was best known as the discoverer of the carbon-14 method of dating ancient artifacts and sites by measuring the ratio of the isotope to ordinary carbon and calculating the passage of time since the source sample was alive to ingest it by breathing or absorbing carbon from the atmosphere, a breakthrough which saw him awarded the 1960 Nobel Prize for chemistry. That discovery had its basis in Libby's research into the uses of various isotopes for nuclear intelligence, with the carbon-14 discovery following Libby's development of a method to measure krypton-85. The technique was based on calculation of the atmospheric load produced by the known emissions of the substance in the West, which was given off in direct proportion to the amount of plutonium produced in reactors.[602] Given the lengthy period of Air Force mistrust of Oppenheimer, it was possible that despite his position as chair of the GAC where he would typically know about such work, the service may have made an early decision to compartmentalize the krypton-85 technique and conceal AFOAT-1's build-out of a global network of stations to monitor it. In the context of the hearing, whatever he did know about krypton-85 was a reminder how little Oppenheimer did not know about the American nuclear program and how potentially informative identifying such gaps may be for historians.

While it is doubtful that General LeMay ever found the destructive power available to his command sufficient, wider knowledge of the relative weakness of Soviet forces that SAC was counterpoised against would have only heightened the troubling knowledge of the shape and extent the Air Force's war plans that boiled up in Oppenheimer at the fateful 1951 meeting that left him so perplexed and troubled. Given that the 1951 memo documenting the early positive results from the krypton-85 method indicated extensive research and development had been successfully completed by the date it was written, the timing of both the meetings and the memo

---

http://www.osti.gov/includes/opennet/includes/Oppenheimer%20hearings/Record%20of%20Classified%20Deletions.pdf. The remainder of page 572 apparently remains unavailable.

601 See page 289-290 and Appendix A for more on Libby and krypton-85.

602 Henry S. Lowenhaupt, "Origins and Applications of Nuclear Intelligence," *Studies in Intelligence*, Central Intelligence Agency, http://nsarchive.gwu.edu/NSAEBB/NSAEBB493/docs/intell_ebb_018.PDF, 2.

correlated with a renewed emphasis on security at AFOAT-1 and the Air Force's suspension of Oppenheimer's access to nuclear intelligence matters.[603] Together with the actions taken against Oppenheimer's security clearance, Oppenheimer's uncertainty on the matter suggested the Air Force was already taking steps to compartmentalize him off from other sensitive areas prior to the rupture in relations between the scientist and the Air Force.

While the full narrative of the management of the telltale noble gas isotope krypton-85 remains to be plumbed as a historical-technological problem, the need to deny the Soviet Union the sort of data that the United States and the United Kingdom were exploiting to assess Russian plutonium production seemed to create a requirement to address its production in Western reactors. However, indications were the radioactive gas was instead simply measured and released much of the time. Krypton-85 made up over ninety percent of atmospheric radionuclide releases between 1944 and 1972 from Hanford's plutonium production reactors.[604] Such a forthright statement made other claims that "No monitoring data for this noble gas is known to exist…" rather laughable, unless a certain premise is considered: Perhaps the AEC never had that information, because AFOAT-1 or some other agency bore sole responsibility for monitoring these systems at AEC production sites?[605] The AEC's successors bear a burden to history to be more truthful than was possible in the past when such clear contradictions exist.

Krypton-85 releases could be construed as serving as a means to communicate American resolve to the Russians, much as some believed atmospheric testing did. It was also possible that partial capture of the tell-tale gas was undertaken as an active deception measure to suggest Western plutonium-239 production was less robust than it was. Whether or not the Soviets engaged in similar analysis of krypton-85 to determine their relative position in plutonium holdings is unknown.

---

603 Memorandum by R. C. Maude and D.L. Northrup, AFOAT/1, for Mr. Robert LeBaron, Deputy to the Secretary of Defense for Atomic Energy, "Notes on Technical Cooperation with British and Canadians in the Field of Atomic Energy Intelligence", 21 March 1951, http://nsarchive.gwu.edu/NSAEBB/NSAEBB7/docs/doc01.pdf. Discussed elsewhere in this document, the NARA holds Headquarters Air Force Air Staff RG 341.10.6 holds a number of documents, many cited elsewhere here, that discuss efforts to tighten and maintain extraordinary security measures. Given repeated waves of frenzied political hysteria about nuclear spies during the early Cold War, the Oppenheimer case was unique as a causative factor for such actions only because of his known, direct relationship with AFOAT-1.

604 R.E. Gephardt, "A Short History of Hanford Waste Generation, Storage and Release" (PNNL/DOE Contract DE-AC06-76RL01830) http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13605rev4.pdf, 11.

605 R.B. Hall, "Letter Report: References for Radioactive Releases to the Atmosphere from Hanford Operations, 1944-1957" (Richland, WA: DOE Pacific Northwest Laboratory, 1991), https://inis.iaea.org/search/search.aspx?orig_q=RN:23030461, 5.

Regardless, the fact that the Western intelligence services knew the United States and Great Britain held a substantial lead in stockpiled fissile materials during most of the Cold War premised on the need to deter what were made out to be uncertainties about the threat the Soviets actually posed throws new light on the very basis of these justifications. Once the cautious conclusions found in the GABRIEL estimates about the very limited utility of thermonuclear weapons due to their enormous fallout were established, self-interest offered a better explanation for why both parties chose to step back from the brink of destruction emerges than concepts of deterrence or "nuclear taboo" alone offer. Given fallout's corrosive influence on the credibility of reliance on nuclear weapons, something there is evidence for in the reactions to fallout by both the Air Force and Oppenheimer, fallout's effects on deterrence must have disturbed policy makers who were loath to make a public issue out of this paradoxical result of less security despite more bombs. Data on the Soviet stockpile gained by krypton-85 monitoring showed that the Russians lagged far enough behind to give hope that the credibility of the nuclear Potemkin village of security that SAC built would never be tested. That alone proved not to be enough for Eisenhower, as discussion in following chapters demonstrates, because the problem of fallout proved pertinent to fallout from testing alone.

A Different Kind of Clearance Suspension:
Longstanding Doubts and Inaction over Loyalty

In order to unpack the unspoken, underlying reasons that the AEC chose to act against Oppenheimer requires questioning assumptions in hearing testimony. Beyond establishing that the warmed over and previously adjudicated charges about Oppenheimer's loyalty long predated the eruption of the case into public view, these urgent claims should be interrogated for credibility because of the obvious lack of haste in which they were addressed if the situation was so dire. What do we know about the conflicts that grew steadily between the Air Force and the scientist? Was there a hierarchy exhibited by these concerns? Have declassifications of relevant documents assembled enough of the jigsaw puzzle of nuclear history piecemeal so that persistent gaps in the historical record can be filled with substantial certainty based on how they fit known features of surrounding evidence?

The original, heavily censored 1954 hearing transcript described how the Air Force harbored misgivings about his personal associations based on stale accusations made even before it was established in 1947 as an independent service.[606] In itself, this left questions about why the Air Force saw no need to act on these prior to 1952 if it believed they were substantive. The notable exception to this relative inaction was the suspension of his "Air Force clearance," which Priscilla McMillan discovered took place in May 1951; seemingly a vital piece of evidence, it went completely unmentioned during the 1954 hearing.[607] Nonetheless, General Roscoe "Bim" Wilson's testimony offered at least a partial description of the service's motivations behind this action, while steering carefully clear of the specifics of this and other actions against Oppenheimer from the office of the Secretary of the Air Force, Thomas Finletter.[608]

Even after Eisenhower's December 1953 order to build a "blank wall" between Oppenheimer and the government's nuclear secrets, as he explained in testimony redacted from the 1954 version of the transcript, the first the scientist apparently heard of any suspension of his clearance was in mid-January 1954, nearly three years after the initial Air Force action. James "Scotty" Reston of the *New York Times* called his home for days, finally buttonholing Oppenheimer for an interview, who demurred to comment. Reston noted that while secret, the December 1953 suspension was quickly and thoroughly communicated worldwide. Reston advised Oppenheimer.

> …that my clearance had been revoked. That was the story he had heard. That this had been cabled, telegraphed and broadcast to Submarine Commanders throughout the Fleet and Army posts throughout the world…[609]

This immediate, global follow-up stands in stark contrast to the years of whispered innuendo, rumor, and veiled attacks in the press that followed the suspension of the "Air Force clearance" that McMillan described. These and other events along the timeline between the 1951 "Air Force clearance" suspension and the December 1953 Q clearance suspension, as well as their starkly

[606] DOE, *ITMO2*, 2567-2569. David Griggs, a former Air Force Chief Scientist, noted that he first been advised of doubts about Oppenheimer's loyalty upon becoming the first employee of RAND Corporation in 1946, when the Air Force was still part of the Army. Later, after being appointed Chief Scientist, he recalled being told at length about Air Force suspicions that there was "serious question as to the loyalty of Dr. Oppenheimer" by Air Force Secretary Thomas Finletter and Air Chief of Staff Hoyt Vandenberg.
[607] McMillan, *The Ruin of J. Robert Oppenheimer*, 152. This was an action taken in May 1951 and identified as such by McMillan. Bird and Sherwin, *American Prometheus*, 445, noted something was going on by the time of the VISTA Chapter Five conflict which came later in 1951, noting that "Vandenberg was so alarmed by Oppenheimer's influence that he quietly removed the scientist's name from the Air Force's list of individuals cleared for access to Top Secret information." In fact, the revocation seemed to involve "above Top Secret" information, even as Oppenheimer continued to hold access to Air Force secrets in the course of both VISTA and the Lincoln Laboratory Summer Study.
[608] See earlier discussion in this chapter of Wilson's testimony. DOE, *ITMO2*, 2342-2403.
[609] DOE, *ITMO2*, 168.

differing nature, suggest the need for a new interpretation of this aspect of Oppenheimer's travails.

The clear-cut and widely communicated suspension of Oppenheimer's AEC Q clearance did not take place until six months after he stepped down as chair of the General Advisory Committee, long after Finletter's earlier, but closely-held action. Until he left the GAC, Oppenheimer continued leading the effort to develop thermonuclear weapons, what SAC wanted most. The prior Air Force action clearly had no effect on his handling of classified material and Restricted Data in connection with that effort or other studies like the controversial Project VISTA report and the Lincoln Laboratory Summer Study where at least some access to Air Force classified information was required. Nor did the service previously raise questions about his performance, which was vital in the successful AEC effort that delivered emergency capability thermonuclear weapons for use by SAC by 1954.[610]

The Special Character of the Air Force's 1951 Suspension of Oppenheimer's Clearance

Explaining the secrecy concealing what Priscilla McMillan identified as the May 1951 suspension of Oppenheimer's Air Force clearance, when it could have served to significantly bolster the case made against Oppenheimer, is a bit speculative, because like GABRIEL and the early history of krypton-85 sampling, so little is known about it. The most obvious clue to understanding what it involved was the stark difference between how it was handled and how the president's order to build a "blank wall" between Oppenheimer and Restricted Data in December 1953 was brought into force. The 1951 clearance suspension was virtually unknown, with even top administrators like Louis Ridenour only discovering it almost by accident.

In June 1951, shortly before David Griggs assumed his post as Air Force Chief Scientist, Ridenour, Griggs's predecessor and on leave from his post as dean of the Graduate School, University of Illinois, and Ivan Getting, Assistant for Development Planning, Deputy Chief of Staff, Air Force, and a brilliant former MIT Radiation Lab researcher, recruited Oppenheimer to assist with a study to support SAC.[611] Visiting Air Chief of Staff General Hoyt Vandenberg to

---

[610] Chuck Hansen, *U.S. Nuclear Weapons: The Secret History* (Arlington, TX: Orion Books, 1988), 1, 62, 68. Planning for the 1954 CASTLE series was just beginning in earnest as Oppenheimer left the GAC in the summer of 1952. Included from the beginning were proof tests of three different "emergency capability" weapons. The first of these thermonuclear weapons were already operationally available prior to CASTLE BRAVO.

[611] McMillan, *The Ruin of J. Robert Oppenheimer*, 68-69. Ridenour clearly supported Oppenheimer's position on the super, helping Hans Bethe and others to write a series of articles, the first appearing in *Scientific American* Vol. 182, No. 3 (March 1950), 11-15, to explain to the extent possible the reasons for the GAC's opposition to building the super.

give him the good news, they instead found the general freaked out by the news of their "success," warning them that "under no circumstances was Oppenheimer to have access to Air Force strategic targeting policies and plans." Getting later claimed Air Force Secretary Finletter refused to testify at the 1954 PSB hearings, leaving Griggs as the fall guy, even though Griggs supposedly asked Finletter to clarify the Air Force's exact position on what it saw as Oppenheimer's failings.[612] Perhaps this explains some of the wanderings in Griggs's story or Griggs's own attempts at placing blame for everything the Air Force saw as a problem on the physicist, much as General Wilson did. It does smack of an effort to obscure the Air Force's very direct hand in shaping much of what occurred in the controversy. It also suggested that the conflict and resulting clearance revocation were not just about nuclear intelligence, but about the results obtainable with thermonuclear weapons, the subject du jour in Air Force planning. Given the preponderance of evidence, this, too, involved fallout.

With the suspension so secret that few knew of it, apparently including Oppenheimer, and his continuing otherwise unfettered access to other extraordinarily sensitive information given he continued to hold his Q clearance until it was suspended by Eisenhower in December 1953, this suggested the 1951 suspension was limited to his access to a program similar to those which are now known as Special Access Programs (SAP). Sometimes referred to as "above Top Secret," the SAP designation protects especially sensitive information with additional safeguards by an even more restrictive application of the "need to know" principle. References suggest that use of the SAP designation formally began in the 1980s, but likely reflected a legacy of treating especially sensitive information in such a manner.[613] Evidence and discussion elsewhere here suggested both nuclear intelligence and fallout's influence on strategic policy and planning were treated in ways quite similar to programs designated as SAPs are now.[614] Unlike the 1953

---

[612] Ivan A. Getting, *All in a Lifetime* (New York: Vantage, 1989), 238-239. Getting was also cited in a National Academies of Science memorial article for Griggs as indicating the early 1951 date for suspension of Oppenheimer's Air Force clearance: http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/griggs-david.pdf.

[613] Arkin, *Code Names*, 13, 18-21.

[614] 1009th Special Weapons Squadron, "Security: Radio-Chemical Laboratories," 10 July 1951, NARA USAF, Air Staff RG 341.10.6. This document restricted access to classified materials to "authorized persons," those with a SECRET clearance of higher and whose "duties require knowledge of and who have been authorized access to 1009th SWS information by this Headquarters. [Chief of Staff, USAF]" The document is dated soon after the May 1951 secret suspension of Oppenheimer's clearance, although nothing specifically connects that finding to the flurry of security memorandums issued that spring. While the document applied to military personnel only, given the high level of security it was all but certain that similar restrictions applied to civilians, given that "Information that radio-chemical labs are operated by 1009th SWS easily discloses [sic] mission of 1009th SWS…"

suspension, the clearance suspension identified by McMillan was most likely selective and concealed, in part to avoid tipping off and alarming Oppenheimer, but also to disguise his relationship to and the existence of these sensitive programs. This accords additional significance to the Air Force's willingness to allow limited testimony and discussion of Oppenheimer's involvement in nuclear intelligence, while fallout remained an effectively forbidden topic.

Science Apart, SAC Missing in Action

The crumbling of its relationship with Oppenheimer despite the value of his scientific expertise also throws new light on how AFOAT-1 increasingly preferred to keep science at arm's length by relying on development of its internal scientific expertise or using the services of outside contractors. The troubled relationship with Oppenheimer that left the Air Force's dependent on outside assistance during the research and development phase standing up AFOAT-1 prior to Joe-1 likely played a role in this insular shift.[615] For the Air Force, the vexing difficulties encountered with collecting and analyzing samples from fission devices strong enough to be useful stood out in sharp relief to the fallout problem Oppenheimer postulated for thermonuclear weapons. If it had been so hard initially to find, sample, and analyze, as Chapter One documented, how could fallout suddenly become a significant threat? The roughly thousand-fold increase in yield thermonuclear weapons produced generated similar increases in their fallout, making it correspondingly easier to detect thermonuclear tests and their contamination of the environment. This dramatic increase in yield reinforced that the problems Oppenheimer foresaw with pursuit of the hydrogen bomb were primarily quantitative, not qualitative.

Between the Lines in Oppenheimer's Own Words

That the problem of cumulative fallout from wartime use of thermonuclear weapons was on Oppenheimer's mind was established at the beginning of his own testimony. Panel Chair Gordon Gray began by asking that the scientist recount the contents of the GAC's 1949 post-Joe-1 reports. Oppenheimer demurred, except in general terms. Nonetheless, he inferred that fallout was a big part of the problem in responding to Joe-1 if national security policy focused on pursuit the super. Despite the secrecy in which the hearing was conducted, Oppenheimer used the opening Gray gave him to make the point that some form of security restrictions on his

[615] Chapters Four and Five will document how the need for detection of underground and high altitude tests pushed AFOAT-1 to again look outside the organization for the expertise needed to address these challenges.

testimony continued to limit his ability to respond completely to every question at the hearing. He could not discuss the "affirmative actions" section except in "general terms I used before" in reference to the design and effects of the super, outlining the report's assessment as "semi-quantitative notions of what it would take, what kind of damage it would do, and what kind of program would be required."

> The essential point there is that as we then saw it, it was a weapon that you could not be sure of until you tried it out, and it is a problem of calculation and study, and then you went to the proper place in the Pacific and found out to what extent your ideas had been right and to what extent they had been wrong…We all hope that by one means or another, the development of these weapons can be avoided.[616]

This was the first of many salient points where simple mention of the forbidden term would have allowed the witness to answer questions in a more direct and accurate manner.

Oppenheimer understood that fallout effects were part of the most basic calculations of the fission reactions provided as far back as Frisch and Peierls' initial fission calculations.[617] Oppenheimer was familiar with at least the basic findings of GABRIEL as chair of the body responsible for directing that project's work. Pointing to the issues the GAC found looming over a thermonuclear weapons program as "semi-quantitative notions… a problem of calculation and study," given that fusion weapons depended on the use of a fission trigger there can be no doubt fallout was included in what was left unsaid because of the hearing's security restrictions. Those at the hearing were reading about it daily in the press in the few weeks since CASTLE BRAVO.[618] While carefully omitting mention of the specific reason for locating testing in such a remote location, Oppenheimer was clearly pointing toward something that was already roughly understood from a theoretical standpoint; while he left it unmentioned, this made it unsuitable for testing in Nevada and led to the requirement for vast spaces of the Pacific test range in order to safely test it; and that data from testing was needed in order to confirm the exact nature of the GAC's theoretical assessment this unnamed threat posed. It was notable that Oppenheimer expressed confidence in the basic assessment by the GAC of the threat this class of weapons posed and that it would hold regardless of how much additional precision was obtained from testing data. His blasé reference to testing in the Pacific was as close as he likely dared get to

---

[616] DOE, *IMTO2*, 258-259.
[617] Otto Frisch and Rudolph Peierls, "The Frisch-Peierls Memorandum," http://web.stanford.edu/class/history5n/FPmemo.pdf.
[618] DOE, *IMTO2*, 269. See block quote on next page.

pointing out that IVY MIKE and CASTLE BRAVO had already confirmed the 1950 GAC's concerns.[619] Only fallout fits among all these considerations.

If doubt remained about the subject of Oppenheimer's comments on the motivations for the hearing, his testimony about the GAC's disputed recommendations left further crumbs that described what could only be references to fallout as both "obvious" yet simultaneously a secret.

> We added to this some comments as to what might be declassified and what ought not to be declassified and held secret if any sort of public statement were contemplated. If the President were going to say anything about it, there are some things we thought obvious and there would be no harm in mentioning them. Actually, the secret ones were out in the press before very long…there are part[s] of it which I think you should read but, for the record, there are parts that I cannot go into here.[620]

With the term fallout off limits as subject matter for direct, unambiguous reference in testimony, this was as specific as Oppenheimer could be about its role. Those in the know about fallout understood; those who were not admitted to this secret compartment, despite the clearance they held permitting admission to the hearing, understood they had to simply play along, a circumstance implicit in Oppenheimer's statement that he must abide by the classified guidelines his defense and the AEC's attorneys were apparently bound by.

The AEC panel's attorney, Roger Robb, then interjected, "I think it might be well for the record to show at this point that the Board has read the entire report." Oppenheimer responded by inquiring, seemingly baffled by the line of questioning under the circumstances, "I see. Then what am I doing that for?"[621] Assuming a prohibition existed on use of the term fallout, these interrogatories to Oppenheimer were apparently directed to test how carefully he would couch his testimony when discussing their substance in the report.

Besides Oppenheimer's own comments indicating his testimony was limited in what he was permitted to say, Priscilla J. McMillan turned up one of the most telling bits of corroboration that Oppenheimer and the other witnesses clearly understood the ground rules and confirmed the

---

[619] Despite a secret withdrawal of at least part of Oppenheimer's Air Force clearance pointed out by McMillan (to be discussed in a moment) and his stepping down as GAC chair, with his Q clearance intact until December 1953 Oppenheimer likely heard considerable confirmatory information about the concerns raised in 1949 after IVY MIKE was conducted. When CASTLE BRAVO took place after Eisenhower's order of a "blank wall" between the scientist and nuclear secrets, Oppenheimer had access to only what was in the newspapers and other publicly available reporting to assess and confirm CASTLE BRAVO's prodigious fallout in the weeks leading up to the hearing. He may not have known much officially about the BRAVO shot's mishap, but he likely found it dismaying confirmation of the 1949 GAC's concerns.
[620] DOE, *IMTO2*, 260.
[621] Ibid, 260-261.

all-but certain prohibition on the use of the forbidden term fallout. In a 1987 interview with James Beckerley, the AEC's classification officer present during hearing testimony, Beckerley conceded Oppenheimer wanted him there to ensure nothing he said could later be used to accuse him of aiding the Russians. Beckerley was frank about what his primary duty was.

> If Oppenheimer or his witnesses had given anything away, they'd have been had up for it, but they knew better than the prosecutors what ought not to be said.[622]

Quite obviously, what was unmentionable above all was fallout.

Gray and Robb's approach struck Oppenheimer as something rather odd given the panel already had the information they both asked about. Oppenheimer, encouraged by his attorney's argument that he should provide his own view on the matter, then proceeded as best he could to convey why the GAC arrived at its controversial decision.

> The real reason, the weight, behind the report is, in my opinion, a failing of the existence of these weapons would be a disadvantageous thing. It says this over and over.[623]

The issue the GAC saw was not their supraconventional effects, which only expand with higher yield via the "square cube" rule and which drew no basic objections from Oppenheimer, AEC Chair David Lilienthal, or the other members of the GAC, moral or otherwise.[624] By process of elimination, the only remaining effect that could generate such an evasive narrative was fallout. Blast and fire on the target could never really be "disadvantageous" to the attacker, but fallout clearly could be – and by then two tests proved it was. Reinforcing that point, Oppenheimer cited Enrico Fermi and I.I. Rabi's minority statement on the expansive nature of this threat, which again clearly applied only to fallout, not blast and fire.

> The fact that no limits exist to the destructiveness of this weapon makes its very existence and the knowledge of its construction a danger to humanity as a whole. It is necessarily an evil thing in any light. For these reasons, we believe it is important for the President of the United States to tell the American public and the world we think it wrong on fundamental ethical principles to initiate the development of such a weapon.[625]

---

622 McMillan, *The Ruin of J. Robert Oppenheimer*, 199.
623 DOE, *IMTO2*, 262.
624 The square cube rule demonstrates that the vast expansion in explosive yield made possible by thermonuclear weapons still tended to concentrate most of this obvious physical damage of blast and fire relatively close to ground zero. Only the fallout travels unpredictably to threaten locations far removed from ground zero.
625 DOE, *IMTO2*, 262.

Again, blast and fire were never "an evil thing considered in any light." No matter how powerful, in practice neither could constitute "a danger to humanity as a whole…" because of the limits the square cube rule placed on the extent of blast damage. Most observers subsequently saw statements like this when raised by scientists as framed in purely ethical terms. It was not. It was raised because fallout from use of such weapons involved massive destruction that went far beyond the battle zone and was persistent with great potential to harm future generations far removed from the conflict that generated it. By necessity in the post-Nuremberg era, technical issues like fallout raised inherent moral and ethical questions about the development of thermonuclear weapons, which were largely driven by what little was known to science about this problem multiplied by the geometric increase in yield they produced. However, it was the quantitative difference in their threat that was the key factor distinguishing thermonuclear designs from fission designs.

Fallout was not explicitly cited at the hearing, but it was certainly on the minds of those making such statements as they attempted to navigate their narratives of the hydrogen bomb around the apparent ban on use of the term. It was not the emotive reaction that the Air Force feared when Oppenheimer or other scientists raised the issue of fallout, either; it was the data-driven aspect of the fallout problem. The Air Force was concerned about concealing its intelligence program, but later as the evidence rolled in confirming the original Frisch/Peierls calculation similarly applied to thermonuclear devices, it was the facts about fallout they really feared, because of their potential impact on public support and budgets to sustain the build-up of SAC then underway.[626]

Oppie then cited the majority statement, which he had joined in supporting.

> In determining not to proceed to develop the Super Bomb, we see a unique opportunity of providing by example some limitation on the totality of war…[627]

This might sharply limit availability of the hydrogen bomb, as well as lead to what the Air Force saw as significant limitations on its strategic planning process. Again, only fallout really fits the bill here as a problematic direct effect of the unlimited yields possible with such a device that also represented a global threat and suggested the need to apply limits to its use.

---

[626] Rhodes, *Arsenals of Folly*, 85. From 1947 to 1957, the Air Force budget averaged 47% of defense spending, compared to the Navy's 29% and the Army's 22%.
[627] DOE, *IMTO2*, 262.

Returning to the intelligence angle, Oppenheimer's suggestion that using the AEDS or a parallel monitoring system to verify the results of diplomatic arms control agreements in his work as a State Department consultant was part and parcel of implementing such limits. On the other hand, the Air Force learned too much via fallout to lose it as a source of vital intelligence. It was fear of losing this productive source that most likely offered an explanation why the service felt going after Oppenheimer while revealing some of the nuclear intelligence work he was involved in through a carefully stage-managed proceeding was worth the tradeoff of risk in order that fallout's problematic nature remain officially cloaked. This was especially so if the word fallout never appeared in the transcript.

Another aspect of the Air Force's strange tango between revelation and continued secrecy at hearing was that the hearing was not just about the past. The presence of General Wilson, a man with similar experience with the use of fallout who nonetheless modeled with care the fact that the word was officially taboo, seemed intended at least in part to remind Oppenheimer to take care about making future statements on this matter, as well as during the hearing itself. Oppenheimer pressed on as best he could.

> These are total views where you try to take into account how good the thing is, what the enemy is likely to do, and what you can do with it, what the competition is, and the extent to which this is an inevitable step anyway.[628]

While crediting Teller and Ulam with the most significant contributions and in spite of obvious signs he should speak carefully, Oppenheimer pointedly noted that what was most important was something described elsewhere in the transcript more succinctly as military utility, i.e. "what you can do with it."[629] Here again, fallout is the only weapon effect that would negatively affect the military utility of thermonuclear weapons, given the square cube rule's limitations on blast and fire.

Knowing from Robb's confirmation that the hearing panel had likely already seen fallout's problematic nature implicitly pointed out in the unexpurgated version of the GAC report, Oppenheimer took the opportunity to skate as close to the sun as possible by referencing the nature, if not the exact term, of fallout's threat.

> The notion that the thermonuclear arms race was something that was in the interests of this country to avoid if it could was very clear to us in 1949…even if

[628] DOE, *IMTO2*, 263.
[629] Ibid, 263-264.

> we could outproduce the enemy…because the world in which great destruction has been done in all civilized parts of the world is a harder place for America to live with than it is for the communists…I do not know enough about contemporary intelligence to say whether or not our actions have had any effect on theirs but you have ways of finding out about that.[630]

Indeed, there were. Without mentioning the word, fallout was reflected throughout Oppenheimer's summation of why the GAC believed, when the United States already possessed a weapon capable of destroying any military target that might be anticipated, it would counterproductive to put evidence on the wind about an even more horrible weapon, a weapon whose effects he referenced only by use of terms almost exclusive in application to fallout: "because the world in which great destruction has been done in all civilized parts of the world is a harder place for America to live with than it is for the communists." This was about as close as Oppenheimer dared get to the argument here about what the hearing was really about, tying in fissile material production and intelligence about it to calculations of the expected results of nuclear war outlined by Project GABRIEL's estimates of fallout's global impact.

Gently, very gently, Oppenheimer then touched the synapse between fallout and the sensitive intelligence nerve.

> I believe that their atomic effort was quite imitative and that made it quite natural for us to think that their thermonuclear work would be quite imitative and that we should not set the pace in this development.[631]

This was Oppenheimer's summation of what could be learned – and given away – from fallout based on his knowledge of what AFOAT-1 was up to, as he emphasized the fact that there were no real nuclear secrets when the results were scattered to the wind.

…the goddamnedest thing I ever saw…

Trying to understand why Oppenheimer simultaneously argued for the expansion of tactical nuclear forces and great caution about thermonuclear weapons, Freeman Dyson later asked Oppenheimer if he regretted the specific position he took in the VISTA report and in more generally supporting the development of tactical weapons. Oppenheimer replied,

> 'No. But to understand what I did then, you would have had to see the Air Force war plan as it existed in 1951. That was the goddamnedest thing I ever saw…' The 1951 war plan was, in short, a mindless obliteration of Soviet cities.[632]

[630] DOE, *IMTO2*, 263-264.
[631] Ibid, 264.
[632] Freeman Dyson, *Weapons and Hope* (New York: Harper & Row, 1984), 137-139.

Dyson argued Oppenheimer hoped to use inter-service rivalry to dampen the arms race, by posing the Army's interests against those of the Air Force. If so, this must have been a short-lived hope, because the massive expansion of the AEC's production capacity for fissile material production underway at that time soon undercut any potential for nuclear scarcity to dampen the arms race within the Pentagon. Dyson's characterization of what Oppenheimer told him suggested he missed part of the point being conveyed. It was the cumulative effect of the mindless destruction that SAC ignored, their fallout, which troubled Oppenheimer. The results of such destruction – the accumulation of fallout that would result from the use of thermonuclear bombs as area weapons rather than a more accurately targeted use possible with lower yield weapons – was what set LeMay's plans for SAC apart.[633] Oppenheimer had clearly if uneasily come to terms with the moral equation of fission weapons, given the wholesale destruction and substantial loss of civilian life against Japan.[634] The "goddamnedest thing" was not mindless physical destruction, but the Air Force's refusal to recognize the cumulative fallout threat caused by the sloppy manner in which SAC planned to go about its business.[635]

Dyson on Fallout's "Mindless" Destruction

Because of the intense pressures on the AEC to increase production after Joe-1, Oppenheimer was conscious of the intimate connection between the increasing availability of fissile material, the size of the Air Force target list, and its potential ability to reach down to targets of ever decreasing priority provided by the growth in the size and diversity of the American nuclear stockpile.[636] Oppenheimer's concern in anticipation of growing nuclear plenty after 1952 was to educate policy makers about the threat cumulative fallout posed. Beyond the

---

[633] LeMay, *Mission with LeMay,* 347-370. While the Air Force long associated "precision" with its policy of strategic bombardment, in practice LeMay had largely set that aside in favor of the explosive metric of putting the maximum tons on target. This was the case with his transformation of the bombing of Japan, recounted in his autobiography. The dearth and imprecision of target information from inside the USSR further encouraged SAC's targeting efforts to think big in terms of yield.

[634] Bird and Sherwin, *American Prometheus*, 309. Oppenheimer famously recited lines from the Bhagavad-Gita following the successful first test of TRINITY in 1945. "Now I am become death, the destroyer of worlds."

[635] SAC had very little accurate target data in 1951. LeMay's war plan had to rely on using the highest yield weapon expended as close as could be determined to the assumed target. Even if most civilian targets were spared, the resulting destruction was likely intended to preoccupy whatever leadership persevered after SAC's initial attack with mere survival at that point. Regardless of any extenuating circumstances such limitations might suggest, the fallout from such a blow represented a threat to others, including the United States, which was unconscionable in Oppenheimer's estimation, thus drawing his descriptive condemnation.

[636] A significant criticism of the Air Force's thirst for high yield weapons was there were very few targets that actually rated such overkill. Having quickly addressed that requirement, the Air Force pursued a far more numerous list of smaller targets where smaller weapons made more sense, even if overkill continued as the order of the day.

GABRIEL study, no one else seemed to be doing the math on this, least of all the Air Force. That was a significant part of the reason why Oppenheimer took the opportunity to engage with Eisenhower as both a commanding general and as commander-in-chief, as well as his efforts to "educate" military officers about nuclear weapons as recounted by Walter Whitman.[637]

Dyson's account left much to speculation, at least in terms of the exact circumstances of the ill-fated meeting involving SAC's war plans. Given the tense standoff underway over interminably delayed military requirements, the issues with planning for production increases and the ongoing Air Force campaign that eventually hounded Oppenheimer from government service, adding in his frank manner and LeMay's own counter to that, whether SAC's commander was present that day or not, there was plenty of room for conflict between the Air Force and the AEC even absent the Oppenheimer factor.[638] Oppenheimer's telling of the tale appeared to reflect a belief that the meeting was a watershed moment in his public service. He may have left the meeting in benign silence, although the Air Force's subsequent reaction suggests he made some comment, whether or not he blurted out the same reaction he recounted to Dyson. Given the issues raised by GABRIEL, Oppenheimer's own inclination to minimize the required yields to something closer to "sufficient" than LeMay was ever likely to accept, and the generous potential range of forecast fissile material production rates, the meeting represented a recognizable tipping point for both the physicist and the Air Force.[639] Oppenheimer likely did not then directly tie it to the end of his career, given how unlikely an outcome that might have seemed at that moment, but he certainly contemplated the end of the world, marinated in a stew of raging isotopes far beyond what GABRIEL warned were the finite limits of nuclear war.

General LeMay, whether he looked Oppenheimer in the eye that day or was later briefed by subordinates on what they considered to be the suspicious outcome of the meeting in their eyes, understood Oppenheimer suggested there were limits to nuclear war. Given his clearly stated dismissal of such ideas, LeMay was not a happy man afterwards. Identifying the date of the meeting, those attending, the minutes, and any follow-up may offer more detailed insight. It

[637] DOE, *ITMO2*, 1642. Walter Whitman argued Oppenheimer did "…more than anyone else to educate the military to the potentialities of the atomic weapon for other than strategic purposes…"
[638] The various accounts do not definitively put LeMay in the meeting room. Even if not present, news about it from those present undoubtedly reached him expeditiously.
[639] See Appendix B for actual annual rates of plutonium production. It was the Oppenheimer-led GAC that undertook most of the planning and initial development work that made these enormous production numbers possible, a remarkable refutation by outcome of the spurious notion that Oppenheimer obstructed progress on the hydrogen bomb.

certainly occurred before the successful first test of the super at IVY MIKE in November 1952 and would have focused on existing war plans, but most likely was influenced by the anticipated availability of the hydrogen bomb SAC so heartily desired. It almost certainly occurred prior to the date Patricia McMillan identified when the Air Force pulled Oppenheimer's clearance, May 1951.[640] Given the obvious goal of the Air Force was to expeditiously obtain the high yield weapons it wanted for the service's plan to transition from fission to fusion weapons, it was the massive nature of the attack that Oppenheimer found so disturbing, not simply the fact that thermonuclear weapons were the means to accomplish it. In 1951, this was the most salient known issue and point of conflict between Oppenheimer and LeMay, the AEC and the Air Force; it seems all but imponderable for any other more significant empirical factor to constitute the basis of the conflict. Oppenheimer was no pacifist, as Wellerstein reminded, but based on what was known of his position of these matters by that date he simply argued a case for matching the weapon to the need in order to minimize fallout.

"Technical Grounds" Only Part of Conflict

Another problem from the Air Force's point of view, consonant with the "technical" problem of the limits of tritium production identified by Wellerstein, was what it construed as an unacceptable suggestion for future stockpile planning in one draft of VISTA Chapter Five. One proposal suggested that fissile material be prioritized in a three-way split. The scenario was to devote one-third of the AEC's production to continue the SAC build-up then under way, with the other two-thirds being divided evenly between building tactical weapon capabilities and growing a war reserve stockpile in case of open conflict with the Soviet Union or other attacker.[641] In a sense, this shift, too, could be construed as disarming SAC as Griggs and Wilson's testimony alluded to was among Oppenheimer's sins.[642] More remarkably, by the date of the hearing, while not adopting the specifics of the draft's suggestion, the Pentagon had adopted the idea of providing a diverse range of tactical weapons for all the military services. In effect, Oppenheimer was indicted for offering a suggestion DOD subsequently found useful and adopted as fundamental policy. The Air Force wanted to spin these efforts as undermining its strategic monopoly, perhaps even as a backdoor way for Oppenheimer to impose de facto limits SAC refused to abide, weakening it by routing fissile material it felt was its due to other purposes.

---

[640] McMillan, *The Ruin of J. Robert Oppenheimer*, 152.
[641] DOE, *ITMO2*, 1748-1749.
[642] Ibid, 2562-2564, 2392-2395.

This was the scenario that Dyson suggested was in play, but again it seems too weak a reed to be the basis of the conflict leading to the hearing.

Walter Whitman, another former GAC member and later chair of the Pentagon's Research and Development Board (RDB), testified that the three-way split was simply an allocation proposal in light of new smaller weapon designs that no longer required sizable bomber aircraft to deliver weapons, which also made more effective use of fissile material, as well as a result of the expansion of the AEC's production capacity.[643] For whatever reason, Whitman made no reference to tritium boosting as a source or technical cause for competition among the military services for fissile material, but simply referred to its scarcity and SAC's monopolistic views on the nuclear stockpile.[644] The nature of this redaction suggested an effort by AEC Chair Lewis Strauss to suppress evidence that contradicted the part of the allegations that suggested Oppenheimer restricted or delayed capacity improvements in order to obstruct development of thermonuclear weapons. The accusations left Whitman "shocked to read any comment that there was an attempt to obstruct progress …"[645]

> There had been in the early days of scarcity a very strongly held belief [of the Air Force] that the bomb was useful in strategic bombing and there had been very little thought given to the expansion of the use of the bomb for other military purposes.[646]

Whitman was forthright in his praise of Oppenheimer's efforts, which in his eyes demonstrated an ongoing commitment to ensure the United States military were without peer in terms of the weapons available to them.

Whitman's testimony made it plain that while the Air Force might have objected to some of the work he did for the other services, it was clear why General Eisenhower, was "particularly interested" in the VISTA Chapter Five draft that so incensed the Air Force. Eisenhower was dual-hatted in his final assignment, with two tasks to be accomplished. On the one hand, he was commander of United States forces defending Europe, badly outnumbered and outgunned by the Soviet forces they might encounter and equipped mainly with World War Two vintage arms. The quick expansion of these ground forces he oversaw as the Korean War raged was intended to discourage any similar Russian initiative in Europe. As commander (SACEUR) of Supreme

643 DOE, *ITMO2*, 1641-1643, 1661-1662.
644 Ibid, 1642-1645.
645 Ibid 1639-1640.
646 Ibid, 1641.

Headquarters Allied Powers Europe (SHAPE), Ike also provided support and encouragement to NATO forces to steel their resolve to resist Russian aggression.[647]

Whitman described how tactical nuclear weapons as presented in VISTA Chapter Five might, at first blush, have seemed like an ideal force multiplier to General Eisenhower.

> [Oppenheimer] more than any other man served to educate the military to the potentialities of the atomic weapon for other than strategic bombing purposes; its use possibly in tactical situations or in bombing five hundred miles back. He was constantly emphasizing the bomb would be more available and that one of the greatest problems was going to be its deliverability, meaning that the smaller you could make your bomb in size perhaps you wouldn't have to have a great big strategic bomber to carry it, you could carry it in a medium bomber or you could carry it even in a fighter plane.[648]

As the leader of the Department of Defense's Research and Development Board (RDB), Whitman saw no problem with Oppenheimer's advocacy. In fact, he welcomed it.

> The idea of a range of weapons suitable for a multiplicity of military purposes was a key to the campaign which he felt should be pressed and with which I agreed.

Even a question from Gordon Gray, the chair of the hearing panel, was parsed as acknowledging how this could lead to an obvious conflict between the Air Force and DOD over nuclear weapons and their effects.

> Did that cause some trouble for him in the Department of Defense?[649]

Whitman granted that it did not endear Oppenheimer with the Air Force.

> The Strategic Air Command had thought of the atomic weapon as solely restricted to its own use. I think that there was some definite resentment at the implications that this was not just the Strategic Air Command's weapon.[650]

His position at DOD likely strengthened Whitman's tendency to see things driven by interservice rivalries, accentuated by the fact that he was a chemist, not a physicist, which he noted had left him hurrying to catch up with the subtleties of nuclear energy when he first joined the GAC.[651] Whitman's testimony thus cast the conflict more as the familiar one of SAC's

---

647 DOE, *ITMO2*, 1645.
648 Ibid, 1642
649 Ibid, 1644-1645.
650 Ibid.
651 Ibid, 1640. While largely resolved in favor of the Air Force by 1954, in the late 1940s it and the Navy were locked in struggle over whether to prioritize building more of the B-36 bomber or aircraft carriers. The tactical nuclear weapons Oppenheimer promoted were likely seen by both services as a way to build nuclear capabilities

argument for nuclear weapons as an essentially strategic that it should control even as he made it clear that the joint services saw the issue as more complex. Whitman's previously redacted testimony clarified that whatever objections the Air Force had about the matter, DOD was thoroughly cognizant of and endorsed the same efforts that the junior service painted as disloyal and subversive. Asked directly, "…would you say whether the military is now following the policy of the broad use of atomic weapons pretty much as you stated…?" Whitman's answer left no doubt. "Yes, of course."[652]

Culture Clash

Central to Air Force culture was its faith in technology to solve problems. Prior to LeMay and Eisenhower's assignment of the mission to the nascent independent Air Force, Ziegler and Jacobson noted that when the need for long-range detection was initially defined, the problem was seen as primarily organizational in nature. The Air Force was somewhat shocked when told by AEC Commissioner Robert Bacher "intensive research would be needed to improve existing techniques and devise new methods." Bacher's views were disturbingly different from the conclusion that 'there were no major technical problems involved,' reached by the original Long Range Detection Committee." The 'insider' belief of the Air Force that long-range detection was an easy task of simply finding and collecting radioactive fallout initially clashed with the 'insider' belief at the AEC that fallout was a very limited phenomenon all but impossible to detect outside of the immediate area of an atomic explosion.[653]

When the issue of what became known as fallout was raised in relation to the TRINITY, Hiroshima, and Nagasaki shots, Oppenheimer predicted that fallout from the bombs dropped on Japan would not be a problem because of the height (1850 feet altitude) selected for detonation. He wrote: "With such high firing heights it is not expected that radioactive contamination will reach the ground.[654] This wartime view of fallout persisted after the birth of the AEC, as did Oppenheimer's influential view on its lack of utility for intelligence purposes. When Tracerlab was hired to assist in establishing analytical capabilities for AFOAT-1, they assumed that the director of the Radiochemical Division at Los Alamos, Roderick Spence, would play a role in

afloat. The Navy saw this as a natural evolution given rapid advances in weapon design by the AEC, while the Air Force likely perceived the new naval capabilities as a challenge to what it considered a settled matter, one of several additional motivations for the Air Force to act against Oppenheimer. However, these interservice rivalries did not represent the sort of seminal flaw that undermined strategic reliance on thermonuclear weapons that fallout did.

652 DOE, *ITMO2*, 1674-1675.

653 Ziegler and Jacobson, *Spying without Spies*, 202-204.

654 Ibid, 204-205.

assisting in and overseeing their work. Frederick Henriques of Tracerlab traveled to Los Alamos to discuss the mentor-mentee relationship he assumed would develop between the two groups. Spence was reluctant to assume this role because, as Henriques later recalled, "Oppenheimer had come to the conclusion that there was no way you could detect radioactive isotopes at long distances from an explosion. It was a waste of time to even try since they were going to be atomized."[655]

Thus, Oppenheimer's initial skepticism about the utility of fallout for intelligence purposes contrasted sharply with his more optimistic views on the potential of seismic and sonic techniques as the Air Force's long range detection (LRD) research and development program ramped-up at the end of 1947, shaping the decisions he made as chair of the Committee on Atomic Energy of the Research and Development Board. The reluctance of the AEC's scientists to become involved with the long-range detection program and the apparent organizational influence of Oppenheimer's pessimism about its potential underwrote the Air Force's decision to use alternatives to the resources available at Los Alamos. The spectacular results achieved under pressure from the newly independent service culminating in discovery of the first Soviet nuclear test provided an interesting model that foretold much about a very similar set of circumstances that would play out in public disarray over the thermonuclear program. Many of the same actors were involved in both disputes. The Air Force leadership's influence was for the most part carefully camouflaged at the hearing, but was significant. While General Wilson was most surprisingly talkative about long-range detection of the witnesses appearing at the hearing, others with the best direct knowledge of the role it played were no-shows; they included former Air Force Chief of Staff General Hoyt Vandenberg, who was deceased, and former Air Force intelligence director General Charles Cabell, who was carefully positioned so that his name did not surface even as his presence was directly invoked at a key point during Wilson's testimony.[656]

The conspiratorial context that swirled around and ultimately swallowed Oppenheimer demonstrated numerous factors serving to encourage Oppenheimer's enemies to pursue him.[657]

---

[655] Ziegler and Jacobson, *Spying without Spies*, 208-210.
[656] DOE, *ITMO2*, 2390-2391.
[657] During the Manhattan Project, most of the loyalty and personnel security issues raised at the 1954 hearings were investigated and dismissed as inconsequential by General Grove's security investigators. The AEC followed with another review in 1947. While arguments among historians about the substance of the allegations continue, there were no subsequent meritorious allegations added to those much-discussed incidents from 1943 and before.

His arrogance was often cited as a personal fault, particularly in connection with his prickly relations with Strauss, with distaste for each other palpable in nearly every account of their interactions.[658] There was also Edward Teller's rivalry with Oppenheimer, partly driven by professional disagreement, but some of it basely personal, as demonstrated by Teller's repeated, unsolicited denunciations of Oppenheimer during the Hungarian's pursuit of his own powerbase by shamelessly catering to the desires of his military sponsors.[659]

These embittered personal histories were aggravated by Strauss's dogged pursuit of Oppenheimer as a security threat, brought about by the physicist's documented, if mostly unsubstantial associations with friends and family on the left. Strauss was a man who worried about security, perhaps to a fault, as another AEC commissioner observed.

> If you disagree with Lewis about anything, he assumes you're just a fool at first. But if you go on disagreeing with him, he concludes you must be a traitor.[660]

The importance of Oppenheimer as the quarry was best summed up by the assessment of one of Strauss's associates in the hunt, William Borden. Well-informed as executive director of Congress's Joint Committee on Atomic Energy in the last years of the Truman administration, Borden was an active co-conspirator with Strauss in building the case against Oppenheimer even after he left the JCAE. With access to Oppenheimer's file over the course of a lengthy investigation, Borden was in position as well-situated as any in government to appraise the centrality of the scientist to virtually all nuclear projects of military importance, feeding Borden's rather paranoid view of the threat the busy scientist posed to the nation. Kai Bird and Martin Sherwin pointed out Oppenheimer's prestige and influence among the American scientific community were as important and irritating to those stalking him as any personal threat he might be to their interests. Borden made his argument – and likely found little disagreement from those who joined him in the hunt – in a sixty-five-page report.

> No other individual in America…had more 'detailed, precision data' about the nation's military and foreign policies than this scientist.[661]

---

[658] Bird and Sherwin, *American Prometheus*, 382-383; 401-402; 429. Strauss was not only an AEC commissioner and, eventually, AEC chairman, but also served as a trustee at Princeton's Center for Advanced Study, where Oppenheimer held a position. In a sense, both were trapped like "scorpions in a bottle" at the university when away from Washington on terms that further aggravated their mutual dislike.
[659] Herken, *The Winning Weapon*, 272; Bird and Sherwin, *American Prometheus*, 437, 443-444, 494; Herbert York, *The Advisors: Oppenheimer, Teller & the Superbomb*. (San Francisco: W.H. Freeman and Company, 1976), 142.
[660] Bird and Sherwin, *American Prometheus*, 362.
[661] Ibid, 472.

As a general statement, the truth of this assertion is obvious enough. Once his contributions in the field of intelligence were taken into account, it magnified Oppenheimer's crucial location within an extraordinary nuclear web of science and secrecy. One must dig deeper for the crucial details that placed Oppenheimer squarely in the bombsights of the Air Force.

Thermonuclear Fallout's Enormous Quantity as a Uniquely Threatening Quality

Fallout became an issue for the Air Force because it significantly problematized the services embrace of thermonuclear weapons as a solution to the 1949 Soviet acquisition of nuclear weapons.[662] The quality of thermonuclear fallout itself was identifiably, but not effectively that different than fallout from fission weapons. The problem the hydrogen bomb presented was the enormous fallout yield such explosions produced, combining the insidious quality of the radiation they emitted in the voluminous quantities made possible by yields geometrically larger than typical fission weapons. This, not merely the qualities of the fallout, formed the basis of the Oppenheimer-led GAC's cautions about development of these weapons. It was the cumulative nature of their use under anticipated wartime conditions that worried Oppenheimer and those on the GAC who supported the cautions that led to the GAC's discouraging report on pursuit of thermonuclear weapons after Joe-1 that so inflamed the Air Force. The question of defining the likely parameters of when total fallout became a general threat to health and the environment formed the basis of Project GABRIEL.[663]

By 1949, the qualities of fallout produced and their quantities in relation to explosive yield were intimately linked by the basic Frisch-Peierls equations and subsequent refinements to

[662] See Appendix A. The only real competitor to fallout's value as an intelligence source in the first decade of the Cold War was a specific radioactive isotope collected and analyzed by AFOAT-1, krypton-85. While this noble gas isotope was also a constituent of fallout, its greatest value was the insight it provided into Soviet plutonium-239 inventories gained by monitoring that via emissions emitted from the reactors used to produce this fissile material.

[663] National Academies of Science, Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council, *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations* (Washington, DC: The National Academies Press, 2003), http://www.nap.edu/catalog/10621/exposure-of-the-american-population-to-radioactive-fallout-from-nuclear-weapons-tests, 36. As noted in the introduction, no assumptions are made about the exact nature of this threat, although it was apparently regarded as significant enough by government officials and scientists to later act on its documented presence in the food chain. However, the best data on fallout should be used to evaluate the question of the risks it poses in nuclear war. What is remarkable here is the continuity of a policy that nearly seven decades later sees the Air Force still keeping the best available data on atmospheric fallout classified. "The committee also recommends that CDC urge Congress to declare a government-wide moratorium on the destruction of documents that are potentially pertinent to measuring fallout in the United States and to mandate declassification of historical fallout-related records."

them provided by fallout data collected by sampling fission reactions.[664] The basis of every workable fusion weapon design was and remains a trigger fashioned from a fission primary stage; many such designs were multi-stage, as CASTLE BRAVO was, with the tertiary fusion reactions focused by the device's uranium case as it is bombarded by thermonuclear radiation from the secondary. This reaction causes the U-238 case to also fission, enhancing the fallout such a weapon design produces. Fusion was often treated as if it were inherently "clean," but fusion also created fallout by a process of neutron induction.[665] The complexity of this issue, compared to GABRIEL's relatively straightforward, if not easily answered experimental question about the relationship of total yield to potential immediate and long-term risk, made it possible for Strauss, Teller, and E. O. Lawrence to persuade Eisenhower that the problem of fallout was solvable through continued testing.[666]

Educating a Future President

SAC's early interest in limiting the access of other services and branches to nuclear weapons was well known, including the summer 1949 confrontation with the Navy over funding the giant B-36 bomber versus new aircraft carriers.[667] This stance remained rather obviously on display in the testimony of Air Force witnesses at the hearing, even though the junior service's impulse toward maintaining an effective monopoly on all nuclear weapons as essentially strategic ones was moribund by the time of the hearing. During 1951 and 1952, the Army was only beginning to assert its own need for tactical nuclear weapons by issuing its first doctrinal circulars and beginning limited test exercises. Both had a notable emphasis on radiological monitoring, as did Army participation in testing in Nevada with its DESERT ROCK exercises in three test series there from 1951 to 1953. Feedback up the chain of command noted more effort

---

[664] Leland Taylor, *History of Air Force Atomic Cloud Sampling* (Kirtland AFB, New Mexico: Historical Division, Office of Information, Air Force Special Weapons Center, Air Force Systems Command, 1963). Keep in mind that while the AEC used fallout test samples to observe the results of bomb design, in practice it was dependent on the Air Force to collect most such samples. This data was generally collected nearby in time and place to the test ground zero. Fallout distant in time and place from a test was generally not supplied to the AEC and was less suitable for design diagnostic purposes given its age.

[665] Hansen, *U.S. Nuclear Weapons*, 69; Hansen, *Swords of Armageddon*, IV-20-25, 60-68, 105, 110.

[666] Greene, *Eisenhower, Science Advice*, 53, 63-65. Teller spent much effort after 1954 denying the significance of fallout. Notably, he, too, pointed out in a 1947 publication that just one hundred hydrogen bombs would raise global radiation exposures to "dangerously high levels." David Hawkins, et al, eds., *Project Y: The Los Alamos Story* (Los Angeles: Tomash, 1983, first edition 1947), 187. Cited in Smith, *Doomsday Men*, 368.

[667] Daniel Ford, "B-36: Bomber at the Crossroads," *Air & Space Magazine* (April 1996), http://www.airspacemag.com/history-of-flight/b-36-bomber-at-the-crossroads-134062323/?no-ist: General Wilson: "I am first of all a big bomb man…," DOE, *ITMO2*, 2375.

was needed to develop force protection measures from fallout, an example of what this project calls the fallacy of "measurement as control."[668]

Notably, a recently released Army official history by Army historian Donald A. Carter of its participation in the early Cold War in Europe made no mention of the 1951 evaluation trip by Project VISTA participants, including Oppenheimer, DuBridge and others who testified in 1954; there they briefed and recorded comments and critiques of the Chapter Five from Supreme Allied Commander, Europe (SACEUR) General Eisenhower. The future president's positive reaction to this part of VISTA report was undoubtedly among the reasons why "the Army had come to see its forces in Europe as a sounding board and test bed for its evolving doctrine on atomic warfare."[669] According to DuBridge and Whitman, Eisenhower and several of his top aides were briefed directly by Oppenheimer's group, with DuBridge's testimony, in particular, making it clear that Eisenhower understood that Oppenheimer's promotion of tactical nuclear weapons was driven in large part because of the necessity to limit fallout's effects if these weapons had to be used in densely populated Europe.[670]

As with Oppenheimer, Eisenhower was not, however, as filled with nuclear enthusiasm as their ready embrace of development of tactical weapons and other such policies might indicate. The relatively low yield, tactical nuclear weapons that Oppenheimer suggested in VISTA Chapter Five as more useful under European conditions provided the means to avoid the use of higher yield weapons that Eisenhower would otherwise have to depend on the Air Force to deliver. Eisenhower commanded American forces that even after a three-fold expansion following the initiation of combat in Korea still found themselves at a ten-to-one disadvantage versus Soviet forces in Europe.[671] Given the fact of Joe-1, the population density of Europe, and the overwhelming numerical superiority of the Russian troops, tanks, and aircraft arrayed against

[668] Measurement seems reassuring, but does not alter the problem of radiation other than to inspire an urge to find distance, shielding, or shelter from it. Measurement as control became a major theme of Civil Defense, with its familiar yellow instruments representing an icon of supposed security in the post-attack environment.
[669] Donald A. Carter, *Forging the Shield: The U.S. Army in Europe, 1951-1962* (Washington, DC: Center for Military History, 2015), 55-58. While he missed the vital VISTA influence on later Army doctrine, Carter did acknowledge that "…the (DESERT ROCK) tests included periodic checks to determine levels of radioactive fallout, however, they demonstrated a lack of understanding of radiation's long-term effects. Army training literature tended to treat the matter rather lightly. It remained for further tests and experiments to confirm the implications of radiation exposure."
[670] DOE, *ITMO2*, 1642-1645,
[671] Donald A. Carter, *Forging the Shield*, 23-24, 35, 56-57. Even without the Oppenheimer angle, VISTA would have been controversial as a tactical air support study. "Senior Army leaders… pressed for ground force control over close air support. This position was anathema to Air Force doctrine and bitterly contested by its officers." Carter, 52.

NATO even after United States forces completed their Korean War-related augmentation, Eisenhower was eager to discuss the advantages low-yield tactical nuclear weapons would bring to such a challenging battle zone, but still cautious about the implications. Carter described what Eisenhower faced in his last military assignment as a lesson learned that he brought along once elected president. [672]

> Eisenhower's experience in World War II, and his analysis of the fighting in Korea, had led him to the conclusion that conventional ground forces were largely obsolete.[673]

Carter's innocence about the VISTA controversy saw it and the fallout problem it intimated was at the root of the future president's misgivings omitted from the factors that perplexed Eisenhower in later shaping nuclear force into national security policy.

What SAC Feared

Given what Oppenheimer hinted at in his comments to Freeman Dyson, as well as what was implicit about the perils of thermonuclear weapons in his previous discussion in early 1950 on Eleanor Roosevelt's radio program prior to Truman's silencing order, coupled with Lee DuBridge's frank observation pointing out "radio activity" was a distinguishing weapon effect that made the use of thermonuclear weapons impractical in Europe, a very different light was thrown on what the Air Force objected to in VISTA Chapter Five. Neither the supraconventional blast nor thermal effects of the hydrogen bomb were mysterious or particularly controversial in light of blast and fire damage from conventional weapons still on display all over the continent when Eisenhower received the visitors from VISTA in late 1951. Only fallout fit the bill as something that disturbingly transgressed beyond this all-too-acceptable damage, as well as drove him as president to draw such ominous conclusions about the nature of nuclear war in eventually shaping a transformative policy replacing confrontation with negotiation. It was also notable that while the tactical nuclear weapons Oppenheimer's team promoted in Chapter Five seemed to offer a more viable alternative, such a limited conflict still threatened imminent escalation into full-scale attacks with high-yield thermonuclear weapons if either party feared defeat on the battlefield. Despite this, by the time of the 1954 hearing a rapid expansion of availability of tactical nuclear weapons was already well underway, with the Army and Navy both set to receive

[672] Donald A. Carter, *Forging the Shield*, 35-37.
[673] Ibid, 80. Despite his misgivings about nuclear weapons on the battlefield, Eisenhower approved their deployment as commander-in-chief when the Army's first tactical nuclear weapon system, the 280 mm cannon, was deployed to Germany in late 1953. See: http://www.usarmygermany.com/Units/FieldArtillery/USAREUR_FieldArty.htm.

significant numbers of operational tactical weapons by mid-decade.[674] What remained notably unresolved in early 1954 about thermonuclear weapons was what was forbidden from mention at the hearing, fallout.

Matched with knowledge of how critical high-yield thermonuclear weapons were in the eye of SAC strategists, the idea that the Air Force was merely defending what it felt was its monopoly fell well short of the concerns the organization had about VISTA Chapter Five. In light of General LeMay's oft-expressed distaste for any practical limits on the use of strategic airpower after having already bombed the Germans (and the Japanese) as the enemy, the Air Force preferred to view fallout simply as collateral damage, part of the price of war, and a tangential concern to its primary mission of destruction of enemy capabilities.[675]

The primary reason for Oppenheimer to come into conflict with the Air Force was his repeated statements about thermonuclear weapons likely proving unsuitable for use, in this case on the European battlefield, was the argument he made about the threat their massive fallout posed to densely populated civilian areas. Oppenheimer's refusal to be silenced about fallout within the scope of his duties, which seemed to have precipitated the confrontation with SAC in 1951, then his subsequent expression of fallout acting as a limit on their use in VISTA Chapter Five, when taken together represented a fundamental threat to the military utility of thermonuclear weapons in the eyes of the Air Force. Arguments about the priority needs of the other military services were largely resolved by the spring of 1954, although these issues did play minor supporting roles in the Air Force's complaints.[676] The high esteem for Oppenheimer's

---

[674] Hansen, *U.S. Nuclear Weapons*, 1, 190-191. The Secretary of Defense ordered a nuclear warhead for the Navy's Regulus cruise missile in January 1950 (in service 1953). The Joint Chiefs approved arming the Army's Corporal missile with a nuclear warhead on 18 December 1950 (in service 1955).

[675] LeMay, *Mission with LeMay*, 380-384; David L. Snead, *The Gaither Committee, Eisenhower and the Cold War* (Columbus: Ohio State University Press, 1999), 84-89; Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (New York: Columbia University Press, 1998), 108-118. While not pointing to fallout as a major incentive for the changes from massive retaliation to a euphemistic "limited war" strategy that still involved hundreds of nuclear weapons while holding thousands more in reserve, Snead offered an excellent capsule summary of the arguments between the services about targeting strategy in the course of the nineteen-fifties. It effectively took a decade to transform SAC's monopolistic vision of strategic policy into one the joint services could come to consensus upon in the form of the first SIOP, SIOP-62, which went into force in 1960. Craig discussed limited war in the context of Kennedy's critique of the troubling strategy and forces Eisenhower left to him. Craig's criticism particularly stands out as missing the context that fallout could provide if its significant influence on Eisenhower's thinking were better understood.

[676] See Appendix B. AEC plutonium production rebounded from 288 kilograms in 1951 to 662 in 1952. In the just concluded year prior to the hearing, 1953 AEC production was 838 kilograms and it would well exceed 1,000 kilograms in 1954.

advice multiplied the threat he represented to what the Air Force saw as the necessity for unlimited use of high yield weapons when the scientist repeatedly urged caution about their use.

On the other hand, the then still unfolding CASTLE BRAVO crisis underlined the fundamental argument Oppenheimer made, although wishful thinking about its outcome prevailed for the time being. In a sense, the Oppenheimer hearing represented a sub rosa part and parcel of initial official reaction to that incident as the United States downplayed fallout's significance before finally partially admitting the scope, if not the full significance, of the problem in a report released in early 1955. CASTLE BRAVO was a public revelation of what Oppenheimer argued behind closed doors, a reminder that the surprise about its fallout expressed by Eisenhower was feigned while the government scrambled to decide how to spin the implications of this closely-held secret to the public.

Filling the Fallout Gap with Inferential Knowledge

Based on the bulk of the evidence and the scientist's own words, clearly something about the use of thermonuclear weapons in SAC's war plan was at the root of Oppenheimer's misgivings about the entire fusion enterprise. Blast and fire inflicted on civilians, even on the enormous scale made possible by a weapon that could be scaled up to whatever yield was desired, were reconstructed from what was considered German terrorism in bombing civilians in Guernica in 1937 by the events, technological capabilities and outcomes in the course of World War Two into acceptable collateral damage by General LeMay and his cohort of Air Force strategic bombing pioneers.[677] Whatever conflict existed between SAC and Oppenheimer, there is no evidence that concerns about blast, fire, or extensive civilian casualties from those effects were at its root. Hiroshima and Nagasaki represented clear punctuation of Oppenheimer's stoic shared views of these grim realities with the military services.[678] Fallout was originally viewed by Oppenheimer as a minor, controllable factor of little practical relevance in the use of such weapons. Thermonuclear weapons changed that equation, because suddenly the potential for wartime fallout went from puny to prodigious. What is known about Oppenheimer's knowledge of and views about fallout beyond the discussion centering on its role in the 1954 hearing?

---

[677] Stewart Halsey Ross, *Strategic Bombing by the United States in World War Two: The Myths and the Facts* (Jefferson, NC: McFarland & Co., 2003), 176-194.

[678] Bird and Sherwin, *American Prometheus*, 298-300, 309. Leaving the control bunker after the success of TRINITY, Oppenheimer waxed from the Hindu poetic into something coarser in reflecting on the achievement, "Now we're all sons-of-bitches…" The month before, Oppenheimer signed off "on immediate use of nuclear weapons" after giving his colleagues a chance to comment on, but not change the decision to proceed.

Substantial, if widely scattered and intentionally concealed evidence pointed to fallout being the single most important technical problem associated with the use of thermonuclear weapons. The massive quantities of fallout produced by thermonuclear weapons anticipated in SAC's war plan constituted the most significant feature that distinguished its effects from the more limited uses of tactical weapons that Oppenheimer actively promoted in the disputed Chapter Five of the Project VISTA report. As a scientist, Oppenheimer's only potential capacity to disarm anything was through his mastery of facts and theory, assuming that was even his intent, rather than the suitable caution he displayed in his duties as a scientific administrator to serve the public interest. Both of the fears expressed by hearing witnesses, that he had in fact influenced those working on the "super" to limit its progress and that he intended to undermine SAC were shown by testimony to be specious, even more so once the October 2014 transcript release was taken into consideration. Like most mythology, both claims aspired to offering a politically acceptable alternative explanation for reality.

In this case, given no other feature of the use of these weapons contemplated in SAC's war plan was of equivalent significance in potentially limiting their use, the idea that Oppenheimer could disarm SAC has only a single plausible explanation, worry that political leaders might get cold feet if they learned the extent of deadly fallout associated with the high yield weapons SAC sought in quantity. With mention of fallout banned from the hearing, Oppenheimer could offer no fundamental specific reason for objection to most aspects of how the weapons were likely to be used. Oppenheimer's concern about SAC's war plan appeared to have been driven largely by the cumulative fallout that would be produced by the large number of weapons that SAC intended to use right out of the starting gate in wartime. This was implicit in the words that Oppenheimer used to close the classified portion of his testimony.

> If the development by the enemy as well as by us of thermonuclear weapons could have been averted, I think we would be in a somewhat safer world today than we are. God knows, not entirely safe because atomic bombs are not jolly either.[679]

The working hypothesis here was that Oppenheimer sought to draw a line between destroying one's enemy and destroying the planet's environment, something theoretically predictable by 1951 even prior to the first thermonuclear test, IVY MIKE, knowledge that was demonstrated through the AEC's 1949 initiation of the Project GABRIEL study under the

[679] DOE, *ITMO2,* 265.

guidance of the GAC chaired by Oppenheimer. Sampling proved that IVY MIKE generated massive fallout, which confirmed the theoretical threat fallout from high-yield weapons posed based on calculations that elaborated on those originally done by Frisch and Peierls.[680] Fallout was also the reason that testing of these weapons was relegated to the remote Pacific even when they had only been described in theory. CASTLE BRAVO emphatically punctuated that point just weeks before Oppenheimer's hearing began.

Blast and fire, while worrisome on the nearly unimaginable scale made possible by thermonuclear weapons, could not represent the crux of the varied concerns that Oppenheimer and the GAC expressed. Only fallout fit the modus operandi as the primary technical problem that created a global risk at yields far short of the yields needed for potential global-scale physical destruction from blast and fire. Only fallout could worry Generals LeMay and Wilson that Oppenheimer's goal was to disarm the most powerful military organization on the planet, because only fallout threatened the planet as a whole.

Another Reason Why Fallout Was a Forbidden Term

In a telling twist that confirmed the general thrust of argument here, the long redacted transcript held another reminder of a more mundane, yet crucial reason why secrecy about fallout was intense enough to force the term's exclusion from the hearing. A substantial part of first AEC chair David Lilienthal's testimony was withheld from the 1954 version. Lilienthal noted the AEC was excluded from Truman's evaluation of strategy and his decision to proceed rapidly with thermonuclear weapons development after Joe-1's detection. Lilienthal recalled this was due to the president's fear that involving the AEC would draw the attention of the Joint Committee on Atomic Energy, the AEC's oversight body, leading to what was seen as the problematic influence of Congress on that decision.[681] Most worrisome, given the GAC's advice to give the matter careful consideration before proceeding, was that Truman worried Congress would probe more specifically into what the GAC's objections were based on. At the hearing, Lilienthal apparently still could not address fallout directly, but there can be little doubt that a

[680] The 1940 calculations by Frisch and Peierls were for fission reactions, but every fusion weapon has at its heart a fission trigger that creates fallout just as it would if used by itself. Similar calculations for fusion weapons undoubtedly existed before IVY MIKE. Data from it and subsequent tests such as CASTLE BRAVO provided a basis to revise and correct these calculations, thereby confirming that a massive increase in fallout accompanied the exponential increase in yield provided by thermonuclear weapons.
[681] DOE, *ITMO2*, 1336-1337.

"technical problem" already known to exist was at the center of the discussion in 1949, constituting the primary source of the conflict between Oppenheimer and the Air Force.

> [W]e take a position as a nation that atomic weapons should and must be eliminated. But our military leaders are depending almost entirely upon nuclear weapons in the event of war. This kind of contradictory position is not merely a defect of reasoning, a faulty argument. It is a positive danger to continue both those courses at the same time. To go ahead on a new cycle of atomic weapons, the super, might well make it more difficult for that defect to be faced and something done about it.[682]

The defect Lilienthal spoke of could be narrowly construed to simply be the emerging over-reliance on nuclear weapons seen as necessary to counter the numerical superiority of Soviet armor and personnel, a defect of strategy. In the absence of evidence that fallout was a confounding problem, that conclusion prevailed. But just the opposite proved to be the case, including the word's banishment from the hearing, something which gave Lilienthal pause but which he seemed to resist by speaking of it in terms of being "not merely a defect of reasoning, a faulty argument. It is a positive danger…"

Reinforcing evidence of his expansive meaning of defect in this context was what Lilienthal said just before he specified the present circumstance came about due to a delusional omission within the government. By refusing to come to terms with an inherent threat produced by this class of weapons, Lilienthal argued this problem transcended mere disputes about strategy by reflecting a new form of horror that threatened humankind and the planet as a whole.

> …the act of going ahead, far from strengthening our defenses or atomic program, would magnify its weaker aspects making it increasingly difficult, if not impossible to face the realities, or to take another course that might save the world from the fury of the atomic arms race…[683]

Lilienthal was as earnest, forthright, and factually informed as any witness at the hearing. Like Oppenheimer's own dogged warnings, his message was ignored by the hearing board – and the president – at the time. Lilienthal could only speak about what was at stake in terms that were muffled and indistinct because that was what was forced on him and other witnesses by the circumstances of the hearing and the clearances they held. The sensitivity of the problem Lilienthal cited that made "it increasingly difficult, if not impossible to face the realities" was because the need to conceal fallout as a problem exceeded even the secrecy about its usefulness

---

[682] DOE, *ITMO2*, 1335.
[683] Ibid, 1334.

as a source of intelligence. Only fallout provided sufficient explanation to account for Lilienthal's statement that thermonuclear weapons would significantly magnify weaker aspects of the Air Force's belief in their military utility.

Conclusion

The hearing, which concluded Oppenheimer's downfall by leaving him silenced, in bureaucratic exile, and with the issue of fallout research suppressed and brought under its control, gave the Air Force most of what it wanted. But the Air Force's seeming win, which effectively ended Oppenheimer's attempts to call attention to the need to limit fallout by limiting yield expended on targets in wartime, proved to be but one battle, rather than the conclusive victory the Air Force sought.

It was not the super, per se, Oppenheimer objected to, but the massive fallout such weapons create when used *en masse*.[684] Historians tend to emphasize the role of the weapon over the weapon effects, thus replicating the official marginalization of the role of fallout. Fallout's friction or resistance as a material actor acted much like the social resistance that characterizes infra-politics.[685] In that light, it is possible to begin to see fallout's influence in gaps and seams in the record, pushing back against those who would exclude or diminish its role.[686] One might reasonably ask, "But fallout was not mentioned once in the thousand plus pages of text of *In the Matter of J. Robert Oppenheimer*"! True, and also true of the longer nearly complete declassified transcript text now available.

---

[684] Here I rely on what was different about thermonuclear weapons, both qualitatively and quantitatively, setting them apart from the tactical nuclear weapons that Oppenheimer urged the military to adopt as far more practical devices. LeMay's commitment to tonnage on target ran headlong into Oppenheimer's realization that the mass of fallout this would create would threaten the United States and the rest of the world even if the Russians might be past the point of caring by then. GABRIEL is the key to understanding this conundrum for Oppenheimer. With the transformation of strategic bombing from terrorism to a model of Taylorist efficiency between Guernica in 1937 and Nagasaki in 1945, mere physical destruction and the accompanying loss of civilian life was within the realm of legitimate state policy. Irradiating the planet's entire population clearly was not, at least for Oppenheimer.

[685] Robin D.G. Kelley, *Race Rebels: Culture, Politics, and the Black Working Class* (New York: Free Press, 1996). Kelley applied a term coined by James C. Scott and used in his studies of peasant resistance as a broader theoretical concept more generally useful in study of history. Kelley applied it to contemporary sociopolitical analysis of African-American communities to include a range of activities from individual acts of self-defense to "institution building" in officially denied spaces. Here the concept of infrapolitics is applied to the immutable effects of fallout in breaking free of attempts to confine its recognition and use to secret communities of politics, intelligence, diplomacy, and military force.

[686] Infrapolitics analyzes the meaning of various aspects of resistance that represent the assertions of the oppressed by means of everyday tactics of personal and group rebellion to the established order. Kelley used it to demonstrate that despite life under slavery, Jim Crow law, and racially disparate law enforcement African-Americans continued to express their free will and demands for liberty through a "hidden transcript" of resistance. Here this concept is merged with ANT's application of the material actor concept to social networks to demonstrate fallout acted as substantive counterweight to the Air Force's desire for what Gregg Herken called the "winning weapon."

Nonetheless, in reading the testimony with a sensitive eye, the linkage of nuclear intelligence and fallout as a technical problem was certainly the elephant in the room overlooked for decades and missed as the primary (but not sole) motivation behind the Air Force's interest in removing Robert Oppenheimer from government service. The intelligence angle was just one aspect of Oppenheimer's peculiar knowledge and unique capacity to argue for a review of nuclear strategy. But it was fallout as a problem that constituted the basis for the Air Force's fear he might use its inevitable link to use of nuclear weapons to uncertain advantage against its interests within the United States government. Questions about his loyalty to the nation were largely red herrings, their relevance more a matter of providing an opportunity to insinuate against Oppenheimer's character than of any substantiated relevance to the accusations raised by Air Force witnesses. But that was just the beginning of the final downward slide in this fraught relationship between Oppenheimer and the Air Force, one that began as early as 1946 and which culminated under circumstances that effectively constituted a show trial.

This was never an argument about the existence of fallout itself. Nuclear weapons inevitably produced it, as the seminal calculations of Frisch and Peierls predicted. What was contested by the Air Force versus Oppenheimer was fallout's location, significance, and meaning. In short, the Air Force's planned use of thermonuclear weapons challenged scientific prediction of fallout's potentially imminent risk. Unveiling its stubborn presence at the hearing despite its implicit status as a factor *non grata* requires unpacking the black box of fallout, treating it as a material actor whose footprints can nonetheless be traced through the wet cement of the early Cold War. Within the Air Force, fallout as an issue went far beyond its value as the most tellingly productive intelligence system of that era. At the highest levels of Air Force leadership, the service's dogged pursuit to silence Oppenheimer's known concerns about fallout at the 1954 hearing demonstrated it recognized that fallout created by these weapons served as a potent constraint on their use. While the relative paucity of direct documentary evidence is of concern, fallout's notable absence at the hearing strengthens a working hypothesis that the 1954 hearing served as a proxy to suppress Oppenheimer's critique of the fallacy of depending on thermonuclear weapons to fight a war. Fallout's exclusion from the hearing artfully avoided the discussion Oppenheimer wanted, but served the Air Force, which did not want on record a hearing that revolved around fallout.

Reframing the Oppenheimer affair here speaks directly to historiographic emphasis. Concentrating on the thermonuclear weapons issue as the dominant factor as many have done created a certain tendency to see the world in the *long-term* structural sense in the same ways as the Air Force did, with the weapon itself as the ultimate source of power, a token or fetish. Certainly the Air Force of 1949 or 1954 often projected itself into the future and did this more strategically than the rest of the Department of Defense, given its dependence on cutting-edge technology. When General Wilson testified at Oppenheimer's PSB hearing "I am first of all a big-bomb man" his declaration echoed throughout the Cold War, most explicitly a decade later in Stanley Kubrick's 1964 *Dr. Strangelove* as Major "King" Kong rode that big bomb down.[687]

What Did the President Know and When Did He Know It?

The revised view of the 1954 hearing made possible by the newly declassified transcripts adds considerable depth to what was previously known about Oppenheimer's repeated briefing of Dwight Eisenhower in detail on nuclear weapons. This occurred on a number of occasions between 1951 and 1953 until shortly before the president ordered a "blank wall" built between the scientist and the nuclear secrets he helped create. Whatever he believed about Oppenheimer before the hearing, by taking action Eisenhower chose to embrace assertions by Edward Teller and others that a technical fix for fallout from weapon designers would prove to be an adequate solution.[688] Eisenhower bet the policy farm on massive retaliation through nuclear superiority. With the vapors of McCarthyism still hovering in the wings, the Air Force and AEC Chair Lewis Strauss persuaded the president he had no choice but to take action, suppressing Oppenheimer's science-based fallout cautions as politically toxic. How could the president trust a man's science, when he did not trust the man? Following Truman's 1950 silencing order on the controversy between the GAC and the Air Force over pursuit of thermonuclear weapons, this further supported a working hypothesis that the military used the 1954 hearing to silence Oppenheimer's voice *within* the government about the limits fallout imposed on nuclear war. That strategic need was the motivation for the concerted effort by the Air Force to drive him off the GAC and replace the AEC leadership with more compliant and supportive commissioners who minimized

---

[687] AEC/Stern, *ITMO*, 681; Reference to image of Major "King" Kong riding the H-bomb out of the B-52 bomb bay from *Dr. Strangelove*, Stanley Kubrick, 1964.

[688] Greene, *Eisenhower, Science Advice*, 119-121, 127, 141-143, 181-184, 230-232. Teller's persistence in taking policy positions on nuclear weapons and a test ban at odds with Eisenhower's likely inspired, but cannot be definitively proved, the president's warning of the threat of a "scientific-technological elite" that accompanied his cautions about an emergent military-industrial complex in his 1961 farewell speech.

the significance of Oppenheimer's guarded warnings about the potential threat posed to human health and the global ecosystem by massive fallout from high-yield nuclear weapons.

In the end, it was not simply the slow accumulation of evidence often cited by historians that explain Eisenhower's changing views about nuclear weapons over two terms in office.[689] That decision was substantially motivated by the collection of fallout data that reinforced an eventuality Eisenhower already feared would come to pass, based on Oppenheimer "educating" him about nuclear weapons. Someone, somehow, chose to fulfill the intent of GABRIEL. The Air Force's fears of fallout's potential implications for its force structure, strategies, and war plans were realized, not by the subversive designs of one man, but by the laws of physics, but only in the sense that this curtailed additional expansion of its force structure.

Testimony at the 1954 hearing showed Eisenhower's later policy shift to end testing was influenced by several face-to-face meetings in which Oppenheimer was known to have laid out the theoretical problems of nuclear war to him. First and foremost among Oppenheimer's concerns was that the massive global-scale fallout thermonuclear weapons produce made any significant exchange of attacks with such weapons an untenable tool of national policy. Oppenheimer tangentially described this in public as the problem of "two scorpions in a bottle."[690] The analogy was generally understood to mean that the two creatures threatened each other equally with death, with no escape from the confrontation. The more subtle point was that because they shared the atmosphere in the bottle, if either contaminated it both would suffer the consequences. The case against Oppenheimer was at its heart an attempt to permanently silence a discussion about fallout; the outcome was soon eclipsed by empirical facts. It proved to be easy to eliminate use of the term at the 1954 hearing; by Eisenhower's second term, accumulating data suggested only by eliminating fallout could the discussion about its strategic implications be silenced. Oppenheimer did not need be found using the word to understand that fallout, while formally excluded, was at the center of the conflict on those fated days in the spring of 1954.[691]

---

[689] A wide variety of cultural approaches evaluating the significance of fallout ranging back to Spencer Weart's groundbreaking *Nuclear Fear* can be usefully read in the new light provided by post-Cold War declassifications.

[690] J. Robert Oppenheimer, "Atomic Weapons and American Policy," *Foreign Affairs* (July 1953), 529. This article was cleared by the government as the published version of Oppenheimer's previously cited February 1953 talk at the Council on Foreign Affairs and also presented to the National Security Council in late May 1953.

[691] The incorporation of fallout into Cold War history suggests a couple of questions about Oppenheimer's own use of the term. Was there any evidence that J. Robert Oppenheimer ever used the term fallout in a public context? In light of the fact that fallout was apparently too sensitive to directly discuss in a closed hearing by those with Q clearances, was there documentation of Oppenheimer's use of the term in any declassified document? As with the argument here, silent absence is not absolutely determinative. However, consistency of non-use is suggestive.

Chapter Four: The Invisible as Inconsequential

1 March 1954

> No nation has ever known catastrophe of the scope that would result from all-out nuclear war. No estimates were published about how long…the areas poisoned by fall-out would have to be evacuated for periods from a few weeks to more than a year. . It might be noted in this connection that it is still unsafe, a year and a half after the 1 March, 1954 thermonuclear test, for the Marshall Islanders to return to the islands from which they were evacuated...[692]

Fallout Overkill: CASTLE BRAVO and the Problem of Fallout

Just before dawn on 1 March 1954 (local time), Japanese fishermen saw a bright flash, then a brilliant "orange-red sun rising in the *west*."[693] At 15 megatons, the yield of the second thermonuclear device, CASTLE BRAVO, unexpectedly became the highest of any tested by the United States. Aggravated by unfavorable winds rising after shot time, its intensely radioactive fallout plume moved beyond the designated danger area before evacuations could take place. Among the first to notice the heavy fallout were a group of twenty-five Air Force weathermen stationed on Rongerik, 130 miles from ground zero on Nam Island, Bikini Atoll. In addition to weather observation, these servicemen maintained a ground monitoring station for the Atomic Energy Commission (AEC) test organization. Eight hours after the shot, the radiation meter went off the scale (it was limited to measurements of no more than 100 milliroentgen per hour.) The weather observers sent a message to headquarters requesting advice; they were told to stay indoors. Early the next day, a seaplane evacuated the group after taking readings of at least 3.2 roentgens per hour at one inch above the ground surface.[694]

The situation of the weather observers eventually called attention to the plight of the island residents, exposed to doses on Rongelap (at 100 miles distance, even closer than Rongerik to ground zero) initially estimated to be as high as 340 roentgens (the total dose was later re-estimated downward to an average range from 100 to 125 roentgens.) Emergency evacuations of the islanders commenced. It was a week before the population was medically evaluated, although the task force determined they quickly began showing signs of radiation exposure equivalent to that suffered by "the Japanese who were about 1.5 miles from ground zero at Hiroshima and

[692] Brig. General (retired) Thomas R. Phillips, "Civil Defense," *Air Force*, Vol. 38, No. 10 (October 1955), 60-61.
[693] Joseph L. Miller, *Under the Cloud: The Decades of Nuclear Testing* (New York: Free Press, 1986), 189.
[694] "Memo for the record re: Evacuation of Rongerik After Shot BRAVO," Operation CASTLE, from Headquarters, Task Group 7.4 Provisional, 14 April 1954. http://www.aracnet.com/~pdxavets/wetokian/memodoc.htm.

Nagasaki." Instructions sent to the medical team reminded them "due to possible adverse public reaction" they were not to discuss the situation with anyone "except those with a specific 'need to know.'" The exposures would have been far higher, except for the evacuation. The average lethal dose, or LD50 (where half of those exposed die within sixty days), for radiation exposure is 400 to 450 rem, with any dose of over 1,000 roentgens considered invariably fatal.[695] Maps showed exposures ranging as high as 3,300 roentgens fell on the edge of Rongelap.[696] Fortunately, instead of being 1.5 miles from ground zero without aid, they were 100 miles away from CASTLE BRAVO's detonation with some limited and haphazard assistance; the islanders were evacuated after suffering the most significant unintended radiation exposures of the entire U.S. nuclear weapons test program.

Worse news was yet to come. As the Japanese fishing vessel, the *Fukuryu Maru #5* (or "Fortunate Dragon" #5), sailed that morning outside the designated security zone, white ashes fell from the sky onto the crew as they worked. This odd incident came just three hours after the enormous flash in the sky to the west they suspected was from a nuclear test. After the ash fall, the entire crew was almost immediately stricken with symptoms of radiation sickness, but their plight was not understood until they returned to port in Japan on 14 March. Their catch of contaminated fish, a staple of the Japanese diet, was sold before testing revealed that it was radioactive, creating a panic when it was recalled.[697] The fish panic spread to the United States, although only fish in Japan was found to be contaminated.

Efforts to keep the massive fallout incident secret and confined to the testing grounds failed, largely because the return to port of desperately ill Japanese fishermen with ready access for journalists to question them provided unequivocal proof civilians were harmed far beyond the zone of blast damage. Due to miscalculation about how efficient the reaction of the bomb's lithium deuteride fusion fuel was in its first full-scale test, the resulting yield was much higher

---

[695] Samuel Glasstone, ed., *The Effects of Nuclear Weapons* (Washington, DC: AEC, 1962), 592-5; Nuclear Regulatory Commission, http://www.nrc.gov/reading-rm/basic-ref/glossary/lethal-dose-ld.html. The term "LD50" is a common epidemiological terms that represents the mean fatal exposure where half of all those exposed would die in the immediate future, currently considered to be 400 to 450 rem

[696] Hacker, *Elements of Controversy*, 143-147.

[697] The market where the fish was landed and sold in Tokyo, then returned via recall for disposal by burial, is the site of plaque dedicated to the fishermen and the vast market dislocation caused by the ensuring panic. More than 850 fishing vessels were found to be contaminated, as well as some 460 tons of fish. Much of the irradiated catch was already consumed before the alarm about the contamination was sounded. Conference with and translation by Maiko Lehman.

than calculated.[698] A public relations disaster for the United States and incitement to a transnational movement against nuclear weapons around the world, CASTLE BRAVO's fallout undermined attempts to portray nuclear weapons as controllable and largely inconsequential, with its effects restricted to military targets.

AEC Chairman Lewis Strauss charged the *Fukuryu Maru* was a "Red spy ship," highlighting again his obsession with secrecy and loyalty, even though it was impossible in any case to keep evidence of such a sizable explosion secret from eventual discovery, as was soon related in the context of the Oppenheimer hearing.[699] In the long run, this fallout incident created a permanent policy marketing problem for the AEC, the U.S. government and any other nation which sought nuclear weapons. The drifting "hot" plumes of CASTLE BRAVO's fallout were a clear-cut demarcation between fallout as almost exclusively a deeply hidden, vital intelligence asset and fallout as a major and very public problem for national security policy.

Failing to See the Light: The Politicization of Fallout

Strauss's public stance that fallout was a Communist plot to discredit the American nuclear program was definitive for many in classifying their views of fallout critics who arose after CASTLE BRAVO. In the context of J. Robert Oppenheimer's upcoming security hearing, it was an alarming incitement, one that proved Senator Joe McCarthy was far from the only habitué of Washington, DC to indulge in such purple prose. A curious aspect of Strauss's red-baiting claims was his inspiration may not have been the usual garden variety, knee-jerk anti-Communism. Instead, it was slightly more sophisticated response to what he believed was a propaganda attack on a legitimate, useful weapon – fallout. Nuclear weapons historian Chuck Hansen noted the AEC actively considered making use of fallout as a weapon as late as the summer of 1954.[700] The AEC became discouraged about it only after it began sinking in fallout was far more of a problem than a desirable feature of nuclear weapons. After digesting a lengthy exposition by Carson Mark, head of the Theoretical Division at Los Alamos, on the possibilities of salting thermonuclear weapons with cobalt, tantalum or other materials to produce heightened levels of fallout, the Commission decided existing designs were plenty nasty enough,

---

[698] Hansen, *U.S. Nuclear Weapons*, 65-66, 68.
[699] Hacker, *Elements of Controversy*, 148-151.
[700] Robert LeBaron, Chairman, Department of Defense Military Liaison Committee, "Report on Atomic Energy - 1949 - 1954, Growth of Military Atomic Knowledge," to the Atomic Energy Commission, attachment to Memorandum for the Secretary of Defense and The Chairman, U.S. Atomic Energy Commission dated 31 July 1954, cited in Hansen, *Swords of Armageddon*, IV-10-15.

radiologically.[701] Only small changes in delivery parameters were required to achieve more intense fallout effects, so it made little sense to design a bomb specifically to generate it.[702]

Facing a growing public backlash over the fallout incident, in secret Strauss virtually salivated over the utilitarian possibilities of fallout as a weapon in a 1 July 1954 letter to the chair of the JAEC Military Applications sub-committee.[703] In the memorandum, Strauss demonstrated the AEC clearly understood the concept of military utility applied to nuclear weapons.

> The possible military usefulness of radiological contamination raises the question as to whether the effects can be intensified or prolonged by adding special materials to weapons.[704]

At the time, Strauss had yet to face the facts that would be outlined in a report later issued in early 1955 on the incident, at that point still clearly considering fallout useful. With strategies like "salting" nuclear weapons in order to create more fallout under active consideration in secret, these documents shed an interesting light on the AEC's subsequent assertions changes in tactics of how weapons were employed could generate less fallout. The flaw in AEC's illusion of control over it was the belief fallout, like nuclear weapons, was subject to close control by humans; small changes in tactics could just as easily lead to *more* fallout with the same weapon. Human beings are less than reliable witnesses, let alone bombardiers. Ultimately, no method proved capable of eliminating fallout by design or to address the far larger challenge of defeating the threat of cumulative fallout posed by general nuclear war.

Fallout was generally underrated as a significant factor in Cold War decision making by scientists, policy makers, and historians.[705] However, empirical evidence of fallout's capacity to

---

701 Hansen, *Swords of Armageddon*, IV-11-12.

702 Burst height above the terrain at ground zero largely determined the volume of fallout from a nuclear explosion. A shot in contact with the earth all but guaranteed extensive fallout would be generated, no matter what its design, even at surprisingly small yields.

703 Robert LeBaron, Chairman, Department of Defense Military Liaison Committee to the Atomic Energy Commission, "Report on Atomic Energy - 1949 - 1954, Growth of Military Atomic Knowledge," attachment to Memorandum for the Secretary of Defense and The Chairman, U.S. Atomic Energy Commission dated 31 July 1954, Cited in Hansen, *Swords of Armageddon*, IV-10-15.

704 Letter dated July 1, 1954 to Senator John W. Bricker, Chairman, Military Applications Subcommittee, JCAE, from Lewis L. Strauss, Chairman, USAEC, in Hansen, *Swords of Armageddon*, 14-15.

705 For instance, York, The *Advisers*, 56, attributed Oppenheimer and the GAC's opposition to the super as rooted in the belief it was generically "too murderous" and "unnecessary," neatly avoiding the consideration he otherwise gives to fallout as a problem with thermonuclear weapons. Louis Strauss famously dismissed the *Lucky Dragon* as a "Red spy ship" rather than seeing its crew as victims of the AEC's miscalculations. Spencer Weart's problematization of fallout as primarily a psychological threat posed by "nuclear fear" remains quite useful, although subsequent declassification provided documents utilized here to point toward empirical gaps at the root of some of his arguments.

shape and revise narratives across a broad swath of Cold War history emerges once it is understood how deeply fallout was secretly embedded in many aspects of the Air Force's first two decades as an independent branch of the U.S. military, as well as the important role it played across the spectrum of national security culture. From tiny details like display of unit badges to really big things, like the limits it placed on yield for each test series, evidence of knowledge of the effects of fallout as a problem was extensive. Some historians of civil defense, like Laura McEnaney and Andrew D. Grossman, incorporated fallout in substantial areas of their work, but by and large the tendency has been to downplay its consequences on the basis of a lack of direct evidence of harm, while insisting on the subjective nature of most fallout anxieties during the era of atmospheric testing.[706] One significant example where the widespread influence of fallout as a problem was seen were the nuclear stockpile objectives revised at the Air Force's insistence in 1950 to prioritize pursuit of high-yield thermonuclear weapons following the detection of Joe-1. These priorities were again revised after CASTLE BRAVO proved fallout was a problem to track more closely the original intent of the Oppenheimer-led 1950 GAC stockpile research and development plan, which emphasized development of smaller, more efficient, tactical weapons.[707]

One example of evidence attributable to fallout's social and empirical effects within the national security establishment was a Military Liaison Committee (MLC) lessons learned report to Secretary of Defense Charles E. Wilson. While clumsily trumpeting having "reached the goal of achieving a family of weapons to meet the military need for a large variety of tactical and strategical (sic) needs," the MLC warned the man from General Motors the thermonuclear weapons development program "which began as a military task some five years ago is becoming a major problem of international politics due to CASTLE BRAVO's fallout."[708] The AEC report on CASTLE BRAVO remained months away from completion; in comparison to the AEC, those handling the definition and fulfillment of military requirements moved quickly out of the blocks in recognizing the potential implications of fallout's catalyzation of an otherwise largely

---

[706] Laura McEnaney, *Civil Defense Begins at Home: Militarization Meets Everyday Life in the Fifties* (Princeton: Princeton University Press, 2000); Andrew D. Grossman, *Neither Dead nor Red: Civilian Defense and American Political Development During the Early Cold War* (New York: Routledge, 2001).
[707] Hansen, *U.S. Nuclear Weapons*, 69; Hansen, *Swords of Armageddon*, IV-140-141.
[708] Robert LeBaron, Chairman, Department of Defense Military Liaison Committee to the Atomic Energy Commission, "Report on Atomic Energy - 1949 - 1954, Growth of Military Atomic Knowledge," attachment to Memorandum for the Secretary of Defense and The Chairman, U.S. Atomic Energy Commission dated 31 July 1954 Cited in Hansen, *Swords of Armageddon*, IV-17.

marginalized opposition to testing. As the body that represented the Pentagon's interests at the AEC, the MLC was unequivocal about the substance of the matter in a way the AEC seemed unable to be in its own report, a stark turnabout in decisiveness on fallout from just a few years before between the two organizations. What was missing from the MLC's somewhat timely conclusion was any explicit recognition fallout was proving to be a significant impediment to the "military task" that was the original goal – creation of a useable weapon of nearly unlimited destructive capability. Acknowledging massive fallout from thermonuclear weapons testing was at the root of the issue, the MLC still appeared to be digesting the implications. The Pentagon was less acutely focused on a detailed grasp on fallout's consequences, marking measures for its control down as seemingly one more military requirement yet to be satisfied, while recognizing fallout was changing the game.

Writing to AEC Chair Strauss, Donald A. Quarles, Assistant Secretary of Defense for Research and Development, encouraged Strauss' rather naïve hope that fallout could become a controllable, even useful feature of nuclear weapons.

> Consideration of the effects of nuclear weapons, particularly those with high yields, indicates that radioactive fall-out and contamination are among their most important characteristics, and indeed may be one of the factors governing their use in some situations.
>
> It also appears that it may be possible to control to a considerable extent, by different weapon designs, the relative amounts of long-lived radioactive products per megaton of total energy yield. It is understood that the AEC is gathering information as to special materials which could be added or substituted to enhance or diminish the radioactive contamination.[709]

As the service most familiar with fallout, as well as with the most extensive responsibility to deliver the weapons that created it, the Air Force's needs remained the primary force driving military requirements, including arguing the need for a weapon with a contact fuse.[710] As the AEC itself noted, the tactics of employment had a great effect on fallout production; whatever its intended target or cleanliness of its design, a weapon equipped for detonation on contact was certain to produce high levels of fallout.

---

[709] Letter dated September 17, 1954 to Lewis L. Strauss, Chairman, USAEC, from Donald A. Quarles, Assistant Secretary of Defense for Research and Development, DOD; cited in Hansen, *Swords of Armageddon*, IV-22.

[710] Use of contact fusing would cause heavy fallout, because the resulting explosion would closely couple the fireball with the earth's surface, significantly increasing the fallout of any particular weapon.

Los Alamos began work on “clean” designs by August 1954 in order to achieve “different contaminating characteristics,” but initially only in the context of being able to both “decrease and increase fallout.”[711] The Pentagon was anxious for active efforts to clarify the fallout or “contamination” problem and strangely unable to let go of the idea radiation could somehow be spun as a benefit. Producing more intense fallout through altering tactics by contact fusing and other means was relatively easy, while altering the design of a weapon to inherently create less fallout was costly in terms of an estimated 75% reduction in yield.[712] One “salt” with the potential to lessen overall fallout, gold, could substitute for uranium in bomb casings, reducing longer-lived isotopes by increasing short-lived isotope production.[713] Hopes for a quick fix to produce less fallout were quickly dashed at the Pentagon.

> There really was no such thing as a totally "clean" weapon: even if all fission yield could be replaced with fusion yield, neutron-induced radioactivity would cause major short-term local contamination for bursts in which the fireball contacted the earth or water. Little consideration had been given to this aspect of thermonuclear explosions, and LASL was planning to undertake a theoretical and mathematical analysis to determine the seriousness of this problem.[714]

Falling Apart

Little more than three years after the AEC grudgingly accepted the uncomfortable task of managing the Nevada Test Site due to fear a fallout incident there might draw unwanted attention to the accelerated United States weapons test program, CASTLE BRAVO demonstrated no test site was remote enough to avoid controversy over fallout.[715] Long interpreted as a journey into the unknown, much as Eisenhower’s longer-standing acquaintance with the problematic nature of fallout is a more accurate summation of his experience than the former model of a slowly growing accumulation of knowledge about it, the circumstances outlined in Chapter Two also suggested AEC leadership was well aware of the dirty nature of their experimental charges.

---

[711] Hansen, *Swords of Armageddon*, IV-51-56.
[712] “Meeting the Threat of Surprise Attack," The Report to the President by the Technological Capabilities Panel of the Science Advisory Committee, Volume II, Executive Office of the President, Office of Defense Mobilization, Washington, D.C., February 14, 1955, p. 57; cited in Hansen, *Swords of Armageddon*, IV-70.
[713] Hansen, *U.S. Nuclear Weapons*, 69.
[714] “Effects of Design Changes,” attachment to notes on Coordination Meeting on the Radiological Contamination Problem held November 9, 1954, Room 3E-1060, The Pentagon under the auspices of the Office of Assistant Secretary of Defense, Research and Development, Technical Advisory Panel on Atomic Energy; cited in Hansen, *Swords of Armageddon*, IV-57.
[715] Hewlett and Holl, *Atoms for Peace and War*, 286, 288-290.

These matters also called into question the unitary view of American national security leadership during the Cold War, exposing fracture lines defined in large part by the nature of the actor's relationship to fallout.[716] For the Air Force, fallout was the fountain of eternal youth, nothing less, with every hot sample collected by AFOAT-1 another reminder about the need for the Air Force's capability to deliver nuclear weapons, the more, the better. For the Army and Navy, fallout was a means of leverage to make their own claims to strategic roles and resources, much as the Air Force accomplished; while arguing in secret to be wary of the perils of fallout in 1957, they were soon sated of such activism by evolution of their own nuclear arsenals. For the AEC, fallout was an often inconvenient but frequently useful scientific marker, but one about which the Oppenheimer affair established the AEC must allow the military the last word.

For the president and his advisers, despite his own experiences permitting an unusual degree of insight into the institutions nominally under his command, fallout had grown into an appalling political and strategic problem as well as an increasingly obvious fatal flaw in the general military utility of nuclear weapons and the national security strategy they supported. Instead of delivering military superiority, the risks posed by the fallout from nuclear weapons undermined the idealized premise of clean, unambiguous military victory they offered, while starkly limiting the choices available to the executive.[717]

Certainly, Robert Oppenheimer and the GAC cohort he worked within understood the problem, though they were mostly gone but certainly not forgotten by 1954. The Oppenheimer hearing's outcome did not so much impose a harsh boundary on allowable debate, because official secrecy continued to conceal much about the role of fallout despite an intense public debate about nuclear weapons, as it suggested the narrow range of politically copacetic news its new leadership desired to hear on the topic. Official expediency thus replaced outright denial of fallout's relevance, a seemingly very ad hoc policy considering the work previously done with

---

[716] It is not that inter-service rivalries have gone unaddressed. Such tales are part and parcel of any Pentagon "insider" memoir, as well as the occasional subject of academic research and comment. The problem has been this has always been pretty thin gruel in the American system, which presumes civilian control but generally defers to military decisions. Eisenhower was best equipped as any president for dealing with the military hierarchy, but the fallout problem, clear-cut as it was by 1957, demonstrated hard facts and a president who was a peer were no guarantee that well-justified policy directives could overcome leadership inertia at the Pentagon.

[717] See pages 298-350 passim for the problematic military utility of these weapons. BUDAPEST studied the problems of nuclear war, concluding U.S. forces might suffer significant casualties along with civilians exposed to fallout from United States strikes on the East. This phenomenon was part of the impetus of nuclear absolutism, until the futility of the radiation problem on the battlefield became overwhelming for friend and foe. How would a president manage such a war as one envisioned by Teller's bands of roving nuclear specialists? Even Teller himself had qualms, page 320-323.

the calculations for GABRIEL.[718] Nonetheless, the indirect acknowledgement CASTLE BRAVO forced on the government that fallout during war might be a problem acquired a permanency like the arsenals it might spring from at a few moments notice, spun out as more of a nagging worry than the harsh reality known to inevitably accompany nuclear war upon execution of SAC's war plans. The momentum of SAC's build-up was politically undeniable, largely because Oppenheimer's fate prevented emergence of a critical public fallout narrative from within the government. LeMay got what he wanted: a force so overwhelming that it would never be tested – so far. It came at an enormous price, so long as it held war in check, when the cost would become an exponentially higher burden. The problem of fallout was even refashioned into a primary reason to justify continued testing. Except during the brief revival of atmospheric testing in the last couple of years before the original three nuclear powers ended the practice in 1963, atmospheric testing from 1955 to 1958 loosed more radiation than humans ever encountered in hope that fallout would soon be defeated by design. Examination of test operations and results after CASTLE BRAVO demonstrated pursuit of the alluring goal of eliminating fallout as a problem was largely fruitless even as evidence of its threat accumulated.

"Emergency" Testing in Nevada and Teller's Grim Failure of Imagination

There was interesting ground to till between the transformation of the research agenda for Project GABRIEL in the period from 1949 to 1953 and the manner in which the AEC viewed the risk from use of the Nevada Test Site (NTS) after it was activated in 1951 as an "emergency" measure during the Korean War. For the AEC, Hewlett and Duncan dispassionately argued, "the hazards of radioactive fallout took on increasing importance…" largely due to the "increasing tempo of weapons testing" at the Nevada Test Site.[719]

Besides the campaign against Oppenheimer, other ominous forebodings suggested the AEC preferred somewhere outside the continental United States as a test site, but chose not to rock this boat by failing to accommodate the Pentagon's desire to learn more about taking

---

[718] Hewlett and Holl, *Atoms for Peace and War*, 264-266, 280-287. A good example of this very selective scramble to explain away the threat of fallout was a limited discussion of GABRIEL followed by a later discussion of GAC input into a 1955 statement on fallout due to the CASTLE BRAVO incident by Hewlett and Holl. The authors do not connect the two, as if amnesia about work already done on fallout set in after Oppenheimer left as GAC chair. In his stead, Willard Libby led an effort that effectively recast GABRIEL as theoretically ineffectual, while casting Lewis Strauss as a strong advocate of "candor" about fallout! The limited evidentiary record the authors had available might justify such a characterization, but like Strauss' promotion of the idea that AFOAT-1 was the result of his nagging the Air Force about it, evidence to support such a notion seemed largely a result of Strauss' actively imaginary self-promotion.

[719] Hewlett and Duncan, *Atomic Shield*, 499; Hewlett and Holl, *Atoms for Peace and War*, 150-161, 288-291.

ground blasted by nuclear weapons in easily accessible Nevada. The public was given assurances that NTS was safe to use; behind the scenes the scientific debate continued.[720] In May 1951, between the winter-time RANGER test series and the upcoming October-November BUSTER-JANGLE series, Shields Warren convened a meeting at Los Alamos to evaluate the risks of using the Nevada Test Site for nuclear testing. Warren concluded "in light of the size and activity of some of these particles, their unpredictability of fallout, the possibility of external beta burns is quite real." In other words, Warren worried that the normally invisible threat fallout represented might suddenly be transformed into a visibly obvious malady. On the other hand, Warren agreed with Gioacchino Failla, a radiological physicist, that "we should take some risk…we are faced with a war in which atomic weapons will undoubtedly be used, and we have to have some information about these things…if we look for perfect safety we will never make these tests." Carrol Tyler of the AEC fretted an untimely fallout incident could lead to loss of the continental test site.[721] These fears, if not the actual risks posed by fallout, raised the ante for those monitoring the tests, making them aware of how important it was to avoid publicity about fallout contamination in an effort to portray these weapons as controllable and utilitarian. The existence of NTS upwind of the majority of the nation's population was implicitly a declaration by the government of the controllable and utilitarian nature of nuclear power. More realistically, Las Vegas was the closest city to the test site, itself an argument that proximity to nuclear explosions was only for those comfortable with risk.

Lewis Strauss was not the only person at the AEC who considered fallout to be a feature, not a bug. Among the usual suspects when it came to thermonuclear enthusiasm was Edward Teller. Soon after the GAC warned of the potential for the super to generate "very grave contamination problems" on a catastrophic scale difficult to imagine, Teller wound up his 1950 "alarm clock" thermonuclear weapon design.[722] Described as an enormous device with a yield of 1,000 megatons, transportable only by ship or submarine, it was "capable of producing disastrous

---

[720] William A. Laurence, "Atom Effects: How to Recognize Nuclear Blast," *New York Times*, 16 August 1950. "Only in exceptional circumstances would the intensity of the [fallout] activity be great enough to constitute a hazard upon reaching the ground."
[721] ACHRE, *The Human Radiation Experiments*, 15
[722] J.R. Oppenheimer, "General Advisory Committee's Majority and Minority Reports on Building the H-Bomb," 30 October 1949, http://www.pbs.org/wgbh/amex/bomb/filmmore/reference/primary/extractsofgeneral.html. Notably, as at the 1954 hearing all involved avoided use of the term fallout, largely agreeing instead to note the danger represented by "the possible global effects of the radioactivity generated by the explosion of a few super bombs of conceivable magnitude… [from which] the consequent great release of radioactivity would have results unforeseeable at present, but would certainly render large areas unfit for habitation for long periods of time."

effects." Teller calculated that if detonated in Leningrad, its fallout plume "might reach Moscow with lethal radiation." Teller mused that the fallout plume of a similar bomb with a ground zero near Washington, DC would send deadly fallout past New York City, perhaps as far as Boston.[723] Later, Teller proposed the possibility of building a 10,000 megaton bomb to the GAC.[724]

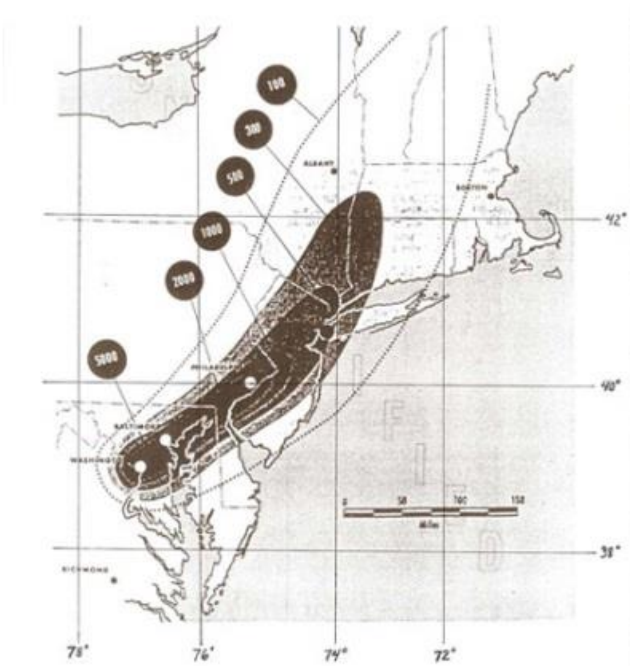

Figure 3: Map of CASTLE BRAVO fallout plume superimposed on United States East Coast map with Ground Zero centered on Washington, DC.[725]

Teller dramatically underestimated the realities of fallout, given that lethal dose levels of fallout from the comparatively petite 15 megaton CASTLE BRAVO test easily reached from Washington, DC to New York City when the map of its plume was superimposed on a map of the East Coast after the 1954 incident. The effects from what would be the far larger weapon the Hungarian-born physicist imagined on the same hallowed ground zero likely meant heavy fallout to Greenland and beyond. By at least an order of magnitude, Teller significantly underestimated fallout effects in this case. Even after nuclear intelligence successes and then thermonuclear

[723] Rhodes, *Dark Sun*, 418-419.
[724] Herken, *The Winning Weapon*, 300.
[725] There are at least two versions of this map. An alternative rendering is here: http://nuclearweaponarchive.org/Usa/Tests/Cbrvusa1.gif. The original source is believed to be the 1955 AEC report on the CASTLE BRAVO fallout incident. Discussion that seems to make reference to these maps begins almost immediately after the report was issued in February 1955. A graphic seemingly based on the map appeared in Hanson W. Baldwin, "H-Bomb Fall-out Poses New Defense Problems," New York Times, 20 February 1955.

explosions made fallout's power more credible, the post-nuclear apocalyptic world it was capable of creating remained too seemingly unimaginable even for Teller.

Like Teller's imagination, Project GABRIEL's conceptual basis failed to keep up with the potential fallout effects posed by rapidly growing plans for nuclear war. The shift in research emphasis from it to Project Sunshine in 1953 followed the quickly rising available megatonnage after the CASTLE BRAVO test in spring of 1954. In 1954, the total potential yield of the stockpile was 386 megatons, rising within a year to 2,819 megatons. The Air Force's infatuation with high-yield thermonuclear weapons quickly and decisively broke through far beyond the limits of nuclear war examined by GABRIEL. Even if Sunshine had dared to continue asking GABRIEL's basic research question about the threat posed by global fallout effects from an Air Force attack on Russia, the model used failed to keep pace with the Air Force's acquisition of ever increasing capability to deliver destructive power on its lengthening target list. By 1957, when the full impact of the expansion in AEC production facilities approved in 1952 was reflected in stockpile expansion, it stood at 16,335 megatons, rising to a 1960 peak of 19,000 megatons.[726] Even after the questionably-timed revision of GABRIEL's original estimate of the danger level from 60 megatons to roughly 2,000 megatons, the prospect of revising what was originally intended as a means to define a limit further upward by another order of magnitude to 20,000 megatons would be absurd. The resulting wartime fallout remained extraordinarily problematic. Concealed from the public, such formal research seeking the answer to the limits of nuclear war was inaccessible except for those with very restrictive clearances. This desiccated outcome stood in stark contrast to the blizzard of relentlessly optimistic statements by Willard Libby about Project Sunshine after its public acknowledgment in January 1956 led to declarations that the risks posed by testing fallout were seen as limited in the eyes of the AEC.[727]

Indications in the record strongly suggest that GABRIEL came under the control of or was at least at the mercy of AFOAT-1's discretion around the time that RAND organized the conference intended to wrap it up in 1953. An AEC memo nonetheless insisted that GABRIEL continued in pursuit of its objective to "determine the practical limits" of nuclear war and would be "accelerated and given a first priority status."

---

[726] "Nuclear Notebook: Explosive Power of the U.S. Nuclear Weapons Stockpile," *Bulletin of the Atomic Scientists*, July/August 1987, 64; Hewlett and Duncan, *Atomic Shield*, 566-568, 576-578, 586; Hewlett and Holl, *Atoms for Peace and War*, 19, 161-162.
[727] Alice Buck, *The Atomic Energy Commission* (Washington, DC: U.S. Department of Energy, July 1983), http://energy.gov/sites/prod/files/AEC%20History.pdf, 9.

> In order to obtain the factual evidence upon which such a study must be based, the Division of Biology and Medicine has sponsored, during the past year and a half, an extended series of investigations by various agencies and organizations which should, when completed, give us reliable information on the meteorological influences controlling fallout of bomb debris, the uptake of fission products by plants and animals, and the ultimate degree of hazard which may be occasioned by such materials.[728]

In November 1953, Dr. Walter Claus, the GABRIEL principal investigator and chief of the DBM's Biophysics Branch, wrote to Brigadier General W.M. Canterbury, AFOAT-1 commander, requesting "bomb fission product samples for certain analyses," specifically for strontium-89 and strontium-90.[729] The request was likely prompted by a review of GABRIEL and associated projects in September 1954 that noted the obvious.

> Analyses of CASTLE series greatly underlined the need for better quantitative measurement of close-in fallout.[730]

While U.S. testing always presented opportunities for research, development, and training, the memo suggested "the Weather Bureau's prediction of trajectories from meteorological data and AFOAT-1 aircraft verification of trajectories" would continue with the data contributed to the Biophysics Branch's work on fallout. Of particular note was that the "[e]ffect of storage of atomic debris in upper atmosphere on local or world climate is drawing some interest among weather experts."[731] The hope was that fallout held aloft would decay significantly before it returned to the biosphere below. With the full impact of CASTLE BRAVO's fallout awaited release of a report then nearly six months away, the AEC was already at work coming up with reassuring theories. Coincidentally or not, GABRIEL faded from the record just as its primary study subject, fallout, was becoming readily available in the wild and Libby's SUNSHINE became the brand of reassurance about American fallout.

While the Air Force's writ probably did not extend to issuing orders about the direction of fallout research at the AEC, the record is clear that AFOAT-1 was kept apprised of the nature,

---

728 John C. Bugher to Brig, Gen. K.B. Fields, "Task Group GABRIEL," 9 March 1953, NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 1. This is one example among many of how fallout uptake in humans seemed to be of comparatively little research interest.

729 Walter D. Claus to Brig. Gen. W.M. Canterbury, "Letter dated 3 November 1953," NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 1.

730 "Trends in Research Program: Biophysics Branch," 8 September 1954, NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 10.

731 "Trends in Research Program: Biophysics Branch," 8 September 1954, NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 10.

direction and results of relevant fallout research. Moreover, the AEC remained dependent on the discretion of the Air Force for much of its data.[732] Considerable documentation of fallout's spread from tests conducted in Nevada was declassified and later made available, but the Project Sunshine documents held by the National Archives and Records Administration at College Park, Maryland hint that much more about fallout's role on the global stage awaits further declassification.[733] A note attached to a map with tracks of the FLATHEAD (365 kilotons, 11 June 1956) plume was suggestive of much greater detail in the classified records.

> Heavy Flathead debris picked up by AFOAT aircraft at 20,000 ft. (see Red arrow, 18 June) If rain occurs, is possible have significant fallout Japanese Islands today or tomorrow. Sample taken at approx. 1 A.M. EDT, analysis not yet available.
>
> Irregular outlined area contains debris from a number of shots intermixed.
> DPZ 6/18[734]

While there was little evidence of a serious pursuit of iodine-131 recorded as the "[m]ost important recent change" in a September 1954 memo, there was evidence that it was of increasing research interest. A memo from the previous fall records collection of milk samples "in both Utah and the Chicago area."[735] By way of contrast with the fading of GABRIEL, the growing pervasiveness of iodine-131 due to testing drew intense interest from researchers.

Utility: Doubt, Hope and Limits of a Stockpile Solution

The Air Force quickly lost its limited interest in fallout reduction, despite the Pentagon's newfound passion for it, even as the political and technological consequences of CASTLE BRAVO became clear. Fallout was something the Air Force valued highly, regarded as a net positive deeply rooted in the service's dependence on it as a source for its most critical intelligence data. The service's general dependence on nuclear weapons, which provided it with comparable stature to the venerable, proven institutions of the Army and Navy, made it

---

732 In some ways, not much has changed in 60 years. In 2001, researchers at the National Cancer Institute and the Centers for Disease Control completed a post-Cold War series of prospective studies undertaken during the 1990s to determine if better data could give more insight into the impacts of exposures to low-level radiation from fallout. More than a decade later, they are still waiting on the Department of Defense to release much of the data the Air Force gathered for intelligence purposes. Mentioned at several pertinent points, the present stalemate will be discussed in the Conclusion.

733 The data produced from plumes sampled of the high-yield tests in the Pacific as well as Soviet and other foreign tests forms the bulk of what remains classified.

734 "Note attached to map with trajectories labeled FLATHEAD," 18 June 1956, NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 2.

735 "Trends in Research Program: Biophysics Branch," 8 September 1954, NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 10; Robert A. Dudley to Gertrude Steel, "Letter dated 16 October 1953," NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73, Box 1.

especially sensitive about factors it saw as potentially limiting their use. The service's aversion to expressions of anxiety over fallout rubbed off on the second weapons laboratory, University of California Radiation Laboratory (UCRL, now known as Lawrence-Livermore National Laboratory, LLNL), when it came to "clean" weapons designs. The junior weapons laboratory chose to constrain itself initially to theoretical work of "general applicability" in limiting fallout, but left any experimental work to its colleagues at Los Alamos.[736] Given the very limited record of UCRL success during its first two test series prior to the 1956 REDWING series, deferring to Los Alamos may have been as motivated as much by a desire to limit the possibilities for further embarrassment as it was about a lack of enthusiasm for "clean" weapons.[737] Whether from guidance initiated by the Air Force or just following Teller's natural disinclination to be troubled over fallout, the contrast between the laboratories was telling. Teller, of course, suffered no indignities over his lab's initial failure to enthuse over fallout reduction, an indictment of the relativistic nature of loyalty, obedience, and priority-setting inside the AEC in comparison to Oppenheimer's experience.

Amid the public furor over the BRAVO report once it was released in early 1955, the idea of a test moratorium, initiated inside the government by Robert Oppenheimer in 1952 to decidedly mixed reviews, resurfaced with AEC Commissioner Thomas Murray. While AFOAT-1 was not mentioned by name, the DOD representative was undoubtedly referring to its operation of the AEDS when he registered the Pentagon's primary reason for its negative reaction to the idea of a test ban with the AEC.

> Under existing conditions of no moratorium, through detection and analysis of Russian tests we obtain intelligence as to Soviet progress in the field of nuclear weapons. This affords us a much better estimate as to the Soviet nuclear capability than would be the case under conditions of a moratorium which undoubtedly would lead to Soviet stockpiling of weapons without complete testing.[738]

Fallout remained too valuable as an intelligence resource for the U.S. military to see much benefit in a test ban.

---

[736] Hansen, *Swords of Armageddon*, IV-114.
[737] "Operation REDWING: Shot ZUNI," Nuclear Weapons Archive, http://nuclearweaponarchive.org/Usa/Tests/Redwing.html.
[738] "Miscellaneous Comments on A Proposed Moratorium," Deputy Assistant to the Secretary (S/AE), April 1, 1955," cited in Hansen, *Swords of Armageddon*, IV-94.

Certainly, there were other reasons the Air Force opposed a test ban, notably so that the AEC could continue thermonuclear weapons development. Following that basic achievement, preserving AFOAT-1's intelligence window into the Soviet's most threatening military project exceeded all others. The United States continued testing in the atmosphere, in significant part because American testing provided a political opening encouraging the Soviet Union to likewise continue the practice – and feeding data on its weapons to AFOAT-1. Fallout possessed extraordinary utility in serving the Air Force's goals, strong evidence that fallout was more valuable – and useful on a daily basis – than nuclear weapons were.[739] The corollary argument was that justification to end fallout must be equally if not more compelling, strongly suggesting a ban on atmospheric testing must have an empirical basis, not simply a political one, in order to overcome what the Air Force saw as the benefits provided by fallout. This was the niche where fallout as a problem insinuated itself and began to grow into a threat to the Air Force's dependence on high-yield weapons. The service's first response was to shut down Oppenheimer, a tactic that proved notably porous as atmospheric testing continued to generate more fallout and opposition.

In grasping for reassuring facts about fallout, the AEC took pains to publicly describe new tactical weapons coming into service as far lower in yield than CASTLE BRAVO, capable of generating only limited fallout. Draft statements demonstrated the AEC anticipated objections to testing at NTS sparked by the fears stoked by CASTLE BRAVO. In preparation for the 1955 TEAPOT series at NTS, the AEC proactively released the planned yield range in hopes of reassuring the public, arguing for the safety of testing in Nevada in relation to the CASTLE-BRAVO post-test incident by acknowledging the 1954 test…

> …did produce heavy fallout over a very large area. <u>But, the device tested was not a tactical weapon such as our Army Navy, and Air Force would use on the battlefield.</u> Our tactical atomic weapons are very much smaller in every way, ranging down to possibly 1/10,000ths of the explosive power released in our test detonation at Bikini a year ago.[740]

[739] The obvious exception to this general rule was the Oppenheimer hearing, where given the hard choice between the two, fallout as an intelligence source turned out to be less important to the Air Force than preserving the perception of the military utility of thermonuclear weapons against what the service saw as Oppenheimer's misappropriation of fallout's subversive narrative.

[740] "Draft of Chairman's Supplemental Statement on Fallout," undated, but probably ca. February or March 1955, Emphasis in original; Hansen, *Swords of Armageddon*, IV-102.

Whether or not Oppenheimer and his GAC compatriots explicitly intended to limit fallout in creating the range of yield options more useful on the battlefield than Teller's super when they drafted the 1950 GAC weapons development plan remains unclear. The 1952 VISTA report explicitly stated a preference for use of tactical weapons over the unwieldly thermonuclear weapons in the development pipeline. However, after CASTLE BRAVO the Pentagon, along with the AEC, seized upon the Oppenheimer-era legacy of tactical weapons in hope of filling an interim stockpile until better designs with sharply reduced fallout could be developed. The circumstances of that ill-fated shot thus also forced another uncomfortable, yet rather obvious linkage before the public; fallout was proportional to yield, forever linking the high yield weapons the Air Force wanted most to a clear stigma against them because of their capacity to generate large volumes of fallout.

A familiar voice also felt slighted in the fallout-constrained test series that followed CASTLE. In a June 1955 letter to Air Force Chief of Staff Nathan Twining following the spring 1955 TEAPOT series at NTS, General Curtis LeMay groused that a third of his bombers "were without weapons," while other commanders had "more than one weapon" per aircraft. In another rehash of the ongoing struggle for priority between SAC and the growing interest in nuclear weapons to equip tactical airpower of the Air Force as well as to serve the varied needs of the other military services, LeMay demanded SAC receive all fissile cores allotted for production over the next year of two classes of weapons, plus a special allocation of pits for another weapon.[741] While LeMay's concerns had more to do with AEC production rates than testing itself, they also reflected his stubborn unhappiness with the limited supply of high-yield weapons he desired versus the quick growth in tactical weapons provided by the maturing development plan set in motion by the 1950 GAC. Despite the enormous resources devoted to SAC, LeMay

[741] Letter dated 6 June 1955 to General Nathan F. Twining, USAF, Chief of Staff, United States Air Force, from General Curtis E. LeMay, USAF, Commander in Chief, Strategic Air Command, USAF; cited in Hansen, *Swords of Armageddon*, IV-115-116. LeMay claimed to have more than 200 combat-ready bombers waiting on weapons. See Appendix D. In 1951 and prior years, SAC's bomber force did outnumber available nuclear weapons. From 1952 on, however, the total numbers of nuclear weapons always exceeded available bomber assets. In 1955, there were 1,260 strategic bombers, with 1,755 nuclear weapons available to arm them. While there may have been shortages of specific desired weapon models, with depot maintenance, transportation and war reserves cutting into the available total weapons, SAC seems unlikely to have fallen as far short as LeMay's letter indicated. See http://www.nrdc.org/nuclear/nudb/datab1.asp.

still felt he was losing the battle for high-yield weapons, a sense of loss which the fallout-constrained 1956 REDWING series did little to alleviate.[742]

LeMay was likely even more exercised a year later in June 1956 when the AEC issued a revised edition of its nuclear weapons effects handbook. Paradoxically, it was Lewis Strauss who initiated the controversy with his objection to adoption of a 100 megaton upper limit for the graphs used to illustrate yields-to-weapon-effects in the AEC handbook. "Strauss stressed the danger of unrealistic yield values on one hand, while noting the possible interpretation by the Soviets that 100 MT was a U.S. goal."[743] Strauss' position was dictated by Eisenhower's promise to limit the yield of the largest American thermonuclear weapons to no larger than CASTLE BRAVO's 15 megatons. Behind the walls of secrecy at the AEC, Strauss's own mounting concerns over fallout were carefully concealed following the firestorm the report on the CASTLE BRAVO incident ignited in early 1955. In public, he and Willard Libby both continued to reassure citizens fallout was a manageable problem with an imminent solution.[744] Perhaps, like the Air Force, Strauss naively believed that after mastering fission and fusion weapons fallout-free weapons would be just another challenge to be overcome with the application of enough scientific resources under more enthusiastic leadership?

Fallout and Military Utility

Rapid development of "clean" weapons was certainly the vision of Congress, as the Joint Committee on Atomic Energy (JCAE) pressured the AEC for quick advances on "clean" weapon designs. Unfortunately, at the same time it linked that call with one for accelerated development

[742] The combination of Soviet acquisition of nuclear weapons and the Korean War precipitated rapid growth in the U.S. military budget. Robert Higgs of the Cato Institute argued that it was the Korean War that provided the impetus to fund the elements of the policies outlined in NSC-68, overlooking Soviet nuclear weapons as the impetus for NSC-68. Higgs nonetheless pointedly identifies the resulting rapid and all-but-permanent tripling of the defense budget, noting, "Between 1947 and 1950 real annual military spending never exceeded $60 billion; after 1952 it never fell below $143 billion." Robert Higgs, Cato Policy Analysis 114: "U.S. Military Spending in the Cold War Era: Opportunity Costs, Foreign Crises, and Domestic Constraints," http://www.cato.org/pubs/pas/pa114.html . An official history of the Air Force's early Cold War build-up states succinctly how the service saw the challenges it faced domestically: "because of the political difficulties (mainly fiscal) inherent in building and maintaining military forces in the United States, strategic air power was the one means by which the nation could be strong at a price it could afford." Walton S. Moody, *Building a Strategic Air Force* (Washington, DC: Air Force History and Museums Program, 1995), viii. SAC was the primary driver for these significant increases. "During the 1950s, SAC received 47 percent of the U.S. military budget. Jerry Miller, Vice Admiral (retired), stated, "Back in those days, it was SAC against the Navy and the Tactical Air Command. SAC had all the money. The best thing you could do was get assigned to a SAC base. They had everything." Jon M. Fontenot, *A New Era: From SAC to STRATCOM* (Quantico: Marine Command and Staff College, undated), http://fas.org/spp/eprint/fontenot.htm.
[743] "Minutes of Ninety-Ninth AEC-MLC Conference, July 5, 1955," 4-6; cited in Hansen, *Swords of Armageddon*, 119-120.
[744] Anthony Leviero, "Cheaper H-Bomb Is Now Possible," *The New York Times*, 12 June 1955.

of very small diameter weapons.[745] Together, these fundamentally conflicting goals recognized no limits on nuclear war or any appreciation for the cumulative nature of fallout's threat under circumstances of war.[746]

> When I speak of small weapons, I mean very small weapons. When I speak of larger numbers, I mean tens of thousands of weapons in this range.[747]

While there was no basic scientific conflict in such a dual directive beyond those which already applied to tactical weapons and the finite nature of AEC resources, such Congressional action indicated ignorance of the limits fallout already imposed on the existing stockpile according to GABRIEL, as well as the potential for increased fallout that widespread tactical use of low yield weapons raised. Due to anticipated deployment of tactical weapons against hard targets under battlefield conditions, primarily armored vehicles and field fortifications, such use was likely to lead to significantly increased fallout because of greater fireball contact with the ground.[748] Likewise, the inefficiency of conversion of fissile material to energy inherent in the design of very small weapons suggested relatively more plutonium-239 and other fissile materials would be left behind or aerosolized to drift away and fall elsewhere.

While Congress pushed for what they believed were inherently more useful tactical nuclear weapons, Eisenhower struggled with the strategic implications posed by thermonuclear war. To handle a review of current and needed capabilities, he turned to General Harold L. George, who was recalled to active duty for eight months in 1955 at the request of Air Force

---

[745] "Report of the Military Applications Subcommittee of the Joint Committee on Atomic Energy, ca. July 29, 1955," 4, cited in Hansen, *Swords of Armageddon*, IV-120.

[746] Ibid, IV-167-171. Generally, "clean" designs were less compact, heavier, and with lower yields than comparable "dirty" designs, all of which made them less desirable as weapons.

[747] Ibid, VI-147-151. Murray described how CASTLE BRAVO changed the equation about what the objectives of the stockpile should be, something which seems directly responsive to LeMay's blind passion for bigger bombs. At the same time, Murray mistakenly presumed that small weapons held the answer to the fallout problem. The issue was further conflicted by the fact that "clean" weapons designs are inherently less efficient, whereas the trend in tactical weapon design in 1956 was toward improved efficiency and lighter weight to maximize delivery system performance.

[748] U.S. Department of the Army, *Atomic Weapons Employment DA Pamphlet 39-1*(Washington, DC: Department of the Army, June 1956); U.S. Army Command and General Staff College, *Nuclear Weapons Employment DA Pamphlet 39-1 Supplement* (Fort Leavenworth, KS: USACGSC, April 1961), author's collection. This pair of manuals represents an unclassified, but restricted circulation tabular compilation of weapon and fuzing options for quick field reference use for a range of weapons from two kilotons to one megaton. The texts made clear the intent to kill via prompt, gamma, and neutron activation radiation were primary intended effects from the employment of tactical nuclear weapons, with calculated doses ranging from 1,000 to 5,000 rad, depending on the desired onset of symptoms of exposure. Fallout was characterized as a secondary effect, usually managed in order to limit its potential to interfere with operations, but at times it was clear it, too, would be used as an intended effect. The tabular calculations of effects for different classes of weapons typically included the option of zero burst height. The exceptions were for some weapons that lacked provisions for contact fuzing.

Chief of Staff Twining. George was the leader of the Air Force's so-called "bomber mafia" of whom Curtis LeMay was the best known. George was a primary advocate of daylight precision bombing, the strategy the Army Air Force trained and equipped for through the first years of World War Two.[749] LeMay superseded that principle with his firebombing tactics in Japan, which served as the prelude to the mass devastation made possible by nuclear weapons. George's findings cemented the Air Force's uncomfortable adoption of the intercontinental ballistic missile as an alternative delivery vehicle to the piloted heavy bombers it relied on. From the beginning it was clear that Eisenhower was leery of the direction of the whole business.

> The President stated vigorously that, if this is the only means of waging war, he would never wage it. If we wage such a war to establish respect for free government in Europe and Asia, we won't have that type of government left ourselves. He thought we should develop a few of these missiles as a threat, but not 1000 or more. The nature of conflict has gotten beyond man. We are getting to the point where it is no longer worthwhile to have the operating staffs study such a war.[750]

Consider Eisenhower's unease with missile technology in light of the fact they would carry thermonuclear warheads, given concerns about hesitancy already raised previously with him over fallout during the 1951 VISTA study interviews as discussed in testimony at the Oppenheimer hearing the previous year. Eisenhower did not ride that roller coaster of frightening twist and turns over the next five years naively. The president was not ignorant of the likely destination of this inexorably frightening journey that instead of security offered only new heights of paralysis amidst quickly growing arsenals of planetary doom. The public saw virtually nothing of this frenetic, yet deeply secret activity, which would later contribute to the surprise felt by many when diplomacy shifted from confrontation to negotiation with the Soviet Union.

AEC Commissioner Thomas Murray expressed a salient point about military utility often lost in the continuing struggle over the mix of weapons in the stockpile and, in particular, the problem he saw with the Air Force's incessant demand for ever bigger weapons.

> ...our stockpile should include only weapons that are actually useful in war.

---

[749] In Europe where LeMay was stationed prior to his transfer to the Pacific Theater, American daylight precision bombing contrasted with the British approach of nighttime area bombing. Regardless of the rhetoric, American bombing practices in Europe eventually shifted toward firebombing and "dehousing," practices, which LeMay then brought to the air war against Japan in the last year of the war.

[750] *Foreign Relations of the United States, 1955–1957, Volume XIX, National Security Policy*, Document 30, "Memorandum of Discussion at the 257th Meeting of the National Security Council, Washington, August 4, 1955."

> Moreover, it should include only weapons that we can legitimately intend to use. I am altogether opposed to any school of thought that would move on toward weapons of ever-increasing magnitude, while at the same time disclaiming the intention of using them.[751]

In case omission of the term meant there was any doubt about Murray's point being the problem of fallout, he continued on to point the finger directly at it.

> Furthermore, a special problem presents itself in judging the military usefulness of large thermonuclear weapons. We know a great deal more about the effects of nuclear explosions than we did a few years ago. For instance, we now know considerably more about the contamination of the atmosphere and soil by radioactive strontium. ...
>
> When the military usefulness of a weapon is being determined, all the knowledge that we have must be brought to bear. Serious account must also be taken of the gaps in our knowledge; these gaps make it imperative to proceed with caution in evaluating the military usefulness of large nuclear weapons.
>
> Here the chief question is this: how does the factor of contamination resulting from large thermonuclear explosions affect the military usefulness of these weapons? Surely it must limit their military usefulness. Indeed, in certain circumstances the factor of contamination might well cancel all apparent military usefulness. This is particularly true in view of the further fact that this contamination lingers for years and would affect life on earth long after hostilities had ended.[752]

Murray was raising the same question GABRIEL raised. Like many of the questions this study raises, discusses and takes a position on based on a preponderance of the evidence, knowing a far more complete unseen record exists even with the door cracked open only enough to see a sliver of what we now know must be in the next room, the combination of context, contingency, and archival evidence initially strongly suggested Eisenhower knew little if anything about the specific premises of GABRIEL. With one exception, circumstances in the direct documentary record to this point suggested the president never was given the opportunity to directly "do the math" by considering GABRIEL's findings, even with its wide uncertainties, amid numerous conversations of stockpile holdings and nuclear strategy.

---

[751] Statement of Thomas E. Murray, Commissioner, United States Atomic Energy Commission, before the Subcommittee on Disarmament of the Committee on Foreign Relations on April 12, 1956; cited in Hansen, *Swords of Armageddon*, IV-148.
[752] Ibid, IV-149.

The only documented early instance of a thorough and unambiguous discussion of this unfortunate conjunction brought about by thermonuclear weapons was the ill-fated report of the State Department's Disarmament Panel, delivered to Eisenhower just as he moved into the White House. In it, the Oppenheimer-chaired panel predicted the early stalemate with Russia due to thermonuclear weapons development, advising that Eisenhower "should tell the story of the atomic danger."[753]

Recent declassification of the full Oppenheimer hearing transcript suggested Eisenhower, like Murray, was at least familiar with the general thrust of Oppenheimer's concerns about fallout acting as an inherent limit to the use of thermonuclear weapons. Such knowledge, given what is known about the president's views and his concerns over surprise attack and nuclear warfare in general, suggested a deeper long-term concern about fallout than the extant evidentiary record indicates. The available record has supported a longer-term, incremental shift in his view of fallout, where it took most of his presidency for him to process the extent of fallout's damage to his policies and strategies through an iterative process.[754] Further analysis suggested instead that Eisenhower's deepest fears, while certainly realized near the end of his presidency, instead of growing incrementally haunted him throughout both terms in office. Regardless of which it was and in spite of great efforts to suppress or minimize its impact, fallout very much "liberated" itself by maintaining its stubborn presence as a strategic factor the president could not afford to ignore. Fallout left few options other than avoiding nuclear war, no matter the heat of public Cold War rhetoric.

It would underestimate Eisenhower's resolve to argue it crumbled having learned from Oppenheimer of the threat fallout posed to American war planning and that he then simply latched onto deterrence and massive retaliation as a suitable alternative. Here, Eisenhower's potentially relevant statements on the matter extended from his "cross of iron" speech in 1953 to

---

[753] Bird and Sherwin, *American Prometheus*, 451. While the language reads dispassionately, given the events of Chapter Three, keep in mind that this phrasing was not in reference to a general danger of war, but the specific danger of radiation from fallout.
[754] Craig, *Destroying the Village*, 68-69, 99. Craig's overall thrust of a presidential "non-policy" on thermonuclear war offered a strong argument to explain how Eisenhower's activist presidency is often remembered for doing little. Craig stuck to analysis of policy arguments, so tended to see a building case against thermonuclear war from inside the national security bureaucracy, the iterative case that best fit previously available evidence. Factoring in fallout actually strengthens Craig's case, although it tends to refocus the narrative from a president making up his mind incrementally on strategy into one of a president helping others see it his way – one that superficially would be a difficult sell. What was striking was how much Eisenhower's end-of-administration viewpoint seemed informed by Oppenheimer's cautionary approach, suggesting with other evidence that his own views were far closer to the disgraced scientist's than generally believed.

his “beware the complexes” speech as his second term drew to a close in 1961, which take on a certain exponential glow of steely resolve under the circumstances. The broad range of possible solutions that fit the evidence suggested what the president knew and when he knew it about fallout was a factor in accounts of how fallout irrevocably insinuated itself into conversation about Cold War strategy at the highest, most compartmentalized levels of government throughout his two terms. It was less any single piece of evidence about fallout’s impact on Eisenhower’s policy and decision making processes than it was the unremitting, cumulative nature of the evidence for Eisenhower’s growing concern about fallout that eventually led him to act to end it. As the full 1954 transcript and other associated evidence confirmed, the seed of Eisenhower’s skepticism about the nuclear endeavor pre-existed his eager participation in the VISTA study.

It remains less important to immediately resolve which context informed the president’s thinking on this matter than to note the profound tensions fallout increasingly called into play during his discussions about nuclear weapons and national security policy and planning over the course of two terms in office. Eisenhower was a quick learner and had little choice but to be a persistent worrier about fallout’s impact on his presidency, with CASTLE BRAVO clearly demarcating mere presidential anxieties over nuclear war from his subsequent committed effort to end testing and seek other means to avoid nuclear war through negotiation.

Shifting Stockpiles and Missing Fallout Data

Continuing the Air Force’s passive-aggressive relationship with the AEC, LeMay’s complaints about a lack of appropriate and sufficient strategic nuclear weapons to equip his bombers were translated into military requirements by the Air Force and communicated to the AEC in February 1956. This document was likely influenced by the anticipated availability of additional fabricated fissile components and material in 1957 with the opening of the Rocky Flats plutonium-uranium composite core facility and another U-235 component line at Oak Ridge. [755]

Here, too, was more evidence of the Air Force’s resistance to interpreting fallout as a constraint. Most of the additional requirements issued through the Military Liaison Committee (MLC) were for higher yield weapons in a variety of configurations. The only slight concession

[755] Letter dated 6 June 1955 to General Nathan F. Twining, USAF, Chief of Staff, United States Air Force, from General Curtis E. LeMay, USAF, Commander in Chief, Strategic Air Command, USAF; cited in Hansen, *Swords of Armageddon*, IV-115-116.

to the growing public pressures generated by fallout was stated as a need for a design that could be configured alternatively, as either a "clean" weapon or as a "salted" one constructed to produce the maximum amount of fallout.[756] Demonstrating the Air Force's thinking on strategic weapons at this point remained largely unaltered by CASTLE BRAVO, the updated set of military requirements continued its call on the AEC to supply a 100 megaton weapon. While Edward Teller was often remembered as a promoter of schemes for enormous thermonuclear devices with potential yields into the thousands of megatons, likely deliverable only by ship, it is important to note that the Air Force played a significant role in encouraging such thinking with their persistent call for a 100 megaton bomb.[757] The Air Force's gratuitously immense military requirements in the face of clear presidential directives to limit the upper yields of thermonuclear weapons even set off alarm bells at the now obsequiously compliant Strauss-led AEC.

> The AEC is not in a position to determine whether a bomb of greater than [deleted] megatons is required by the military. However, the Joint Chiefs of Staff should be asked to inform the President of their stated requirement and should ask Presidential sanction before we proceed with production.
>
> Presentation to the President should include information as to the destruction [sic] effects and strategic benefits to be expected from use of these larger weapons, and in general terms, the price (if significant) (of the development and production of high-yield weapons in terms of) the (loss) of other (lower-yield) weapons. The views of the (Atomic Energy) Commission should be part of the (presentation) to the President.[758]

It is important to note that Commissioner Murray's assessment of the Air Force's deep sense of denial almost two years after CASTLE BRAVO omitted explicit mention of fallout as a weapons effect needing review by the president.[759] Once again, fallout was the dog that did not

---

[756] The Air Force's continued interest in bombs capable of configuration for enhanced fallout production suggests that its war planners anticipated using fallout as a primary weapon effect to contaminate target zones.

[757] Hansen, *Swords of Armageddon*, IV-128, 138-143, 146-147. Teller's passion for bizarrely enormous multi-megaton weapons was discussed at this blog entry: Alex Wellerstein, http://nuclearsecrecy.com/blog/2012/09/12/in-search-of-a-bigger-boom/.

[758] Atomic Energy Commission, Statement of Commissioner Thomas E. Murray at Hearings before the JCAE on February 23, 1956, Report to the General Manager by the Director of Military Application; cited in Hansen, *Swords of Armageddon*, VI-147.

[759] Greene, *Eisenhower, Science Advice*, 98. In a clear sign of the discord between Murray and his colleagues, Murray subsequently testified in support of an agreement to ban H-bomb testing, due to its easily detectable nature, before the Senate Subcommittee on Disarmament in April 1956. Greene argued, "Significantly, Murray did not base his proposal on any concerns with fallout; he asserted that 'the evidence presently available does not warrant stopping tests now for this reason.'" Like Oppenheimer, however, Murray's concern was not so much testing as war and the cumulative fallout it would bring about. This is one example where a more nuanced view of fallout would actually strengthen Greene's argument while better portraying the conflict between science and policy it created.

bark, by its absence foretelling nearly unfathomable dread lurking just outside the boundaries of proper discussion. Eisenhower was, at the least, so reluctant to address the matter except with the closest of confidants that his views or even his knowledge of basic facts seemingly remained obscure in the mind of those he had delegated the authority necessary to deal with nuclear energy and its benefits and problems.

Ten Years After, the Pentagon Suddenly Discovers a Problem

In March 1955 as fallout brought a sense of crisis to the AEC, the Commission anticipated reaction to the long-awaited publication of its essentially dismissive public report on the CASTLE BRAVO incident. Secretary of Defense Wilson wrote to Strauss, outlining the Pentagon's alarm over the fallout issue as its implications sank into the minds of its war planning staffs. The Joint Chiefs believed the Air Force had solved the fallout problem by showing Oppenheimer the door, yet their reactions suggested the Pentagon, as well as Strauss, wanted to feign a certain distant, naïve ignorance radiation just might be involved with nuclear weapons.

> Information that we have received from the [Atomic Energy] Commission and studies that have been made by Defense Agencies [sic] all indicate the great importance that should be attached to the radioactive by-products of high-yield bombs.
>
> Until the CASTLE tests confirmed the feasibility of megaton yields at comparatively small cost, military economy in the atomic weapons field had been largely dominated by blast effects and means of maximizing these [effects] in relation to design and delivery costs.
>
> As important as these blast considerations still are, we are now confronted with perhaps even more important considerations in the radioactive by-products field…the areas subject to lethal radiation are so large, that in planning the use of these weapons we must carefully weigh the damage to friendly as well as enemy installations.[760]

Thus, fallout as a problem first appeared on the radar of many weapons designers and war planners as if it were an almost unknown, just-discovered phenomenon that could be exploited as a useful military effect. However, fallout's problematic nature was also clarified, given recognition its damage could not be confined to the enemy.

Fallout's sensitivity as an intelligence method created the basic conflict that drove much of the AEC's reluctance to divulge information about it, but CASTLE BRAVO's

[760] Letter dated March 5, 1955 to Lewis Strauss, USAEC, from C. E. Wilson, Secretary of Defense; cited in Hansen, *Swords of Armageddon*, IV, 78-79.

problematization of dependence on thermonuclear weapons created an even greater issue for national security strategists. The AEC's avoidance of a forthcoming account about fallout could be written off as due to its politically embarrassing and problematic nature, which was correct as far as it went, but this was never more than very partial motivation for the government's actions or silences on the matter of fallout. As with the AEC's Oppenheimer hearing, the real motivations for policy and decision making involving fallout were disguised by credible, yet obviously now insufficient omissions of fact. The very concept of a "clean" nuclear weapon was just one example where a comforting discourse was enlisted to provide reassurance to the public about testing, even when such efforts were unlikely to alter the fundamental nature of the cumulative nature of fallout from a nuclear war involving thousands of nuclear weapons.

Thus, the overriding issue preventing a forthright discussion within the United States government about fallout at the time of the CASTLE BRAVO incident was the existing silence imposed by fallout's role as a critical contributor of strategic intelligence, which was reinforced as recognition grew that it undermined the strategy of massive retaliation. Similar to how secrecy about sources and methods limited the president's ability to respond to later controversies over bomber and missile intelligence "gaps" that also politically troubled Eisenhower, the 1954 incident forced a narrative into public view even as the government was loath to reveal the details of fallout's threat.

Fallout Trouble at the United Nations: The Problem When the Truth Is a Secret

Having ignored – and worse! – misgivings about testing in Nevada and Oppenheimer's cautions on fallout, the AEC was ill-prepared when CASTLE BRAVO brought fallout scandalously into the transnational public eye. Nuclear weapons historian Chuck Hansen observed that the Eisenhower administration gave serious consideration to joining a proposed United Nations test moratorium "as a way to let public opinion against weapons development cool down a bit."[761] The meticulously factual Hansen focused as was his wont on weapons testing, not on the fallout angle, even though fallout was relentlessly intertwined with his narrative of weapons development. Despite a focus on high-yield weapons for the Air Force at CASTLE, when the military was asked which of its weapons programs it might be willing to

[761] Hansen, *Swords of Armageddon*, IV-7.

relinquish testing under a threshold test ban, the program of research and development of lower yield, tactical weapons regained place of priority.[762]

A suggested threshold test ban upper limit set at 5 to 10 kilotons yield would allow the United States to continue tactical weapon development relatively unhampered. The Pentagon argued in favor of the need for continued testing with any agreement short of complete and satisfactory arms control. Continuing his characteristic role as the government's loudest internal skeptic of AFOAT-1's work, Admiral Strauss sniffed "the large margin of error involved in the long-range detection process" meant any threshold yield limit was an essentially meaningless proposal. An Operations Coordinating Board (OCB, responsible for marketing U.S. policy to foreign audiences) discussion in August 1955 considered an apparently poorly-vetted proposal consisting of a "check list of actions to reduce world antagonisms to U.S. nuclear weapons tests." Although approved by the Pentagon, among the options it outlined was an obvious non-starter, despite its superficial attractiveness for propaganda purposes: "release data on the global effects of Soviet weapons tests."[763] Despite having already handed an outline of its basic nuclear intelligence dossier to the Russians courtesy of Kim Philby, the secrecy shrouding AFOAT-1's work meant many in the Pentagon itself were not yet aware of the highly sensitive nature of fallout as intelligence data.

It was unclear if any action was taken on this specific proposal, although it was hard to imagine anything other than outright rejection once it was read by more knowledgeable reviewers at the Pentagon. Moreover, the OCB's lackadaisical timing in addressing the issue internally more than a year after the CASTLE BRAVO incident was indicative of a generally poorly-managed official reaction by the American government to the public relations disaster fallout became after 1954. If more detail were to be released beyond the bare sketch found in the AEC's and State's existing periodic announcements of many of the Soviet tests AFOAT-1 detected, the OCB's proposal would have compromised the capabilities of the AEDS in ways far more radical than the moribund 1952 Oppenheimer/Department of State panel proposal to initiate a thermonuclear test ban. The proposition also failed to recognize the thankless task of

---

[762] A threshold test ban bans any tests larger than an agreed yield, but it creates problems of verification given the limitations of LRD capabilities to discriminate accurate test yield estimates at or near the threshold.

[763] John von Neumann to W.F. Libby and Thomas E. Murray, "Memorandum," 5 May 1955. Reacting to an earlier United Nations request that may have prompted the OCB's suggestion, von Neumann advised that such information was Restricted Data and could not be released even to "friendly nations." Cited in Hansen, *Swords of Armageddon*, IV-109-111.

trying to disentangle the public's examination of Soviet data from that created by tests of U.S. weapons.[764] Fallout owed allegiance to no one; the policy-marketing gurus of OCB inexplicably believed they could sell the benefits of 'good' American fallout to the public at the same time they attacked 'bad' Russian fallout.

Transnational Political Pressures Piggyback on Internal Fallout Disarray

Transnational concerns about fallout added to the domestic political pressures on the AEC. 1955 also saw a request from the United Nations for the United States (as well as the USSR and Britain) to provide an accounting of the total quantity of fission products released by testing since 1945. John von Neumann warned Libby and fellow AEC Commissioner Thomas E. Murray that answering the UN request would disclose restricted information and compromise critical design data that could then be extrapolated from the known yield of their primaries.[765] Even more worrisome was potentially disclosing a "dirty" secret connected to Project Sunshine's strontium-90 studies.

> Indeed, if we did, so, we might mislead the (UN commission) since we know the former amount exceeds the latter, as far as we can determine the latter, by the factor of about 10. In other words, about 90% of the bomb fission products are, at this moment, unaccounted for.
>
> Furthermore, the steadily continuing increase of strontium-90 deposition on the ground indicates that at least part of this "unaccounted" quantity is not removed forever from the biosphere. This latter information is also restricted data, and of a highly sensitive nature.[766]

Difficult as it is to believe in the present, at least initially the AEC and the military clung to the hope this finding provided that a significant part of the total fallout generated simply vanished into thin air, never to return, even though it was clear it had to be conserved somewhere. To those inclined to believe, this theory was the basis to argue the problems of

---

[764] Throughout the primary era of atmospheric testing, the United States retained a substantial lead in yield tested over the USSR until 1962. Raising questions about the Soviet effort was quite likely to raise similar questions about American nuclear testing and fallout production.
[765] John von Neumann was a polymath Hungarian immigrant who served as a key principal with the Manhattan Project, helping resolve the many issues connected with the implosion design of the Fat Man device. He aided Teller and Stanislaus Ulam with calculations of the Teller-Ulam design configuration of the first U.S. thermonuclear weapons. An original fellow of the Institute of Advanced Study at Princeton and thus a colleague of Oppenheimer and Strauss, von Neumann played a vital role in quantum mechanics, early computer science, and in the development and application of game theory to economics. Eisenhower appointed von Neumann as an AEC commissioner in March 1955, where he served until his death in February 1957.
[766] "Memorandum dated May 5, 1955 for W. F. Libby and Thomas E. Murray from John von Neumann;" Cited in Hansen, *Swords of Armageddon*, IV-110.

fallout were minimal. It was a finding that paralleled the initial struggles to simply reliably detect fallout as the Air Force frantically scrambled to stand up nuclear intelligence operations before August 1949. Obviously, despite the efforts of Libby and Project Sunshine, outside of AFOAT-1 surprisingly little was yet understood about the life-cycle of strontium-90.

Reflecting his own appreciation of the sensitivity of the information in the U.N.'s request, von Neumann was even more exercised in his memo about the U.N. request for information on "total radiokrypton production," an apparent reference to his concern it could compromise the MUSIC program's monitoring of krypton-85, what he termed "restricted data of high sensitivity, and it is at present clearly illegal to communicate it to anyone under any conditions." However, von Neumann – possibly naively – acknowledged the legal subterfuge of AFOAT-1's continued nuclear intelligence work with the British despite the overall ban on such exchanges – von Neumann stated only that "the British very probably possess a good estimate of this" and possibly the Russians, too.[767] Readers of Michael Goodman's *Spying on the Nuclear Bear* and earlier parts of this work understand there was ongoing, quite active cooperation on krypton-85 data between the British and AFOAT-1.[768] Given the continued success of MUSIC, it was an open question whether the Russians had a basic understanding of krypton-85 – or they might have taken countermeasures. On the other hand, the lack of evidence of any reaction suggests the possibility the Soviets used its emissions to communicate their capacity to stand toe-to-toe in a nuclear faceoff with the West. Von Neumann's indelicate handling of cooperation with the British, other than to dissuade Libby and Murray from further thoughts along this line, suggested that the AEC itself was not fully cognizant of the full extent of AFOAT-1's long running cooperation with the British in this field. Given Strauss's infamous Anglophobia, AFOAT-1 cutting him and the AEC out of the loop on this matter was an entirely plausible solution to his objections to undertaking cooperation with the British on a vital project in the eyes of the Air Force.[769]

REDWING: Enter the "Energy" or Fallout Budgets

As the dust settled in 1955 after release of the CASTLE BRAVO report, Strauss optimistically wrote to Secretary of State John Foster Dulles that the upcoming 1956 REDWING series was planned with fission yields totaling less than 25% of CASTLE, with total series yield

---

767 Von Neumann; Cited in Hansen, *Swords of Armageddon*, IV-111.
768 Goodman, *Spying on the Nuclear Bear*, 3, 202, 211.
769 Zeigler and Jacobson, *Spying without Spies*, 194-195.

(fission + fusion) predicted as less than one half of CASTLE.[770] To achieve this goal, fallout-forced changes in test procedures at REDWING on the Bikini Atoll were extensive. The imposition of what was effectively a “fallout budget” of total yield for the series heightened existing competitive tensions between Los Alamos and Livermore.

Officially termed an "energy budget,” it assigned fixed limits for the whole series for total explosive yield of the series and the total fission yield. The total yield limit was approximately 20 megatons (actual total 20.82 megatons), and the actual fission yield was 9-10 megatons (less than the CASTLE BRAVO fission yield alone). The apportionment of the allowed total yield and fission yield between the two weapons laboratories (Los Alamos and UCRL - University of California Radiation Laboratory) were subject to bitter dispute. Many high yield designs were tested at reduced yield, and a number of "clean" (low fission yield) megaton-class devices were tested (but also some very "dirty" ones).[771]

Because of the fallout budget at REDWING, competing demands to incorporate tests of both “clean” and “dirty” designs led to conflict. Willard Libby, then acting AEC Chair in place of an ailing Strauss, gave priority to “clean” designs. In order to stay within the allotted 20 megaton fallout budget, Libby hoped to limit work on “dirty” designs to only theoretical test shots, but was forced by military requirements to fit in two full scale test shots.[772] Of REDWING’s seventeen shots, only FLATHEAD (365 kiloton) and TEWA (5 megaton) were “salted” to increase their fallout intensity.[773] The exact number of “clean” shots depended on how the counting was done, but included multiple variants of three different designs. The paradox of a fallout-constrained yield total impeding research on that very problem may have perplexed Libby, but simple math likely told him he could make more progress on “clean” weapons if research on them was not joined at the hip with research on new “dirty” weapons. As complacent as the man often was about public health, Libby was likely satisfied the AEC knew well how to make dirty bombs and thus believed they deserved a relatively low priority.[774]

---

[770] Letter dated October 25, 1955, from Lewis L. Strauss, Chairman, USAEC, to John Foster Dulles, Secretary of State; cited in Hansen, *Swords of Armageddon*, IV-128. Strauss was accurate in his prediction. Total yield for REDWING came in at just less than 21 megatons. See Appendix D.

[771] “Operation Redwing,” http://www.nuclearweaponarchive.org/Usa/Tests/Redwing.html.

[772] Letter dated May 4, 1955 to Charles E. Wilson, Secretary of Defense, from W. F. Libby, Acting Chairman, USAEC, in Hansen, *Swords of Armageddon*, IV-109.

[773] A “salted” weapon has added elements intended to enhance fallout production.

[774] Hansen, *Swords of Armageddon*, IV-109.

Thinking Small or "Clean": It's Only Relative

To meet the sudden shift in enthusiasm towards smaller nuclear weapons following the CASTLE series, REDWING tested a number of very low yield designs. The smallest, YUMA, with a diameter of just 5 inches, was 2 feet long and weighed just 96 pounds, intended for firing from the U.S. Army's ubiquitous 105mm light howitzer. While not quite a fizzle at 0.19 kiloton, YUMA failed to achieve its predicted yield by a wide margin, although other very small designs were tested successfully at REDWING.[775] Such a weapon would have dramatically increased the flexibility of Army tactical nuclear weapons employment at the time. In 1956, the only operational Army nuclear artillery was the ponderous M65 280mm cannon.[776] Weighing over 80 tons, this apparatus was 84 feet long and required power and steering units at both ends to maneuver on the narrow roads of West Germany and South Korea where it was deployed. In contrast, the 105mm howitzer weighed 2.5 tons, could go anywhere a jeep could, and was transportable by helicopter. The Army never standardized a nuclear munition for the 105mm howitzer due to technical issues with the 5 inch diameter pit, choosing instead to develop and deploy 8" and 155 mm artillery shells and the man-portable, very short range Davy Crockett unguided rocket. While the "atomic hand grenade" was a mythical distraction, after 1955 the AEC turned a significant part of its weapons development efforts to emphasize producing smaller, more agile nuclear weapons intended primarily for tactical use, whether in the air, on the ground, or at sea.[777]

Vernacular measurement

ZUNI was another significant REDWING shot, with the twin attributes of being the first fully weaponized American 3-stage device (fission-fusion-fusion) and the first successful UCRL thermonuclear design. ZUNI was considered a "clean" design deriving 85% of its yield from fusion. Nonetheless, ZUNI rained fallout at rates of up to 150 roentgens/hour scattered over

---

[775] http://www.nuclearweaponarchive.org/Usa/Tests/Redwing.html; Letter dated October 12, 1955 to Senator Clinton P. Anderson, Chairman, JCAE, from Lewis L. Strauss, Chairman, USAEC; cited in Hansen, *Swords of Armageddon*, IV-125-126; in addition to YUMA, REDWING shots BLACKFOOT, KICKAPOO, and OSAGE were all very low yield devices.

[776] By 1956, the Army also fielded rockets and missiles armed with nuclear warheads. The Honest John unguided rockets were not as accurate and the Redstone guided missile was even more ponderous to move and emplace than the M65 cannon, although they offered advantages in range over conventional artillery.

[777] This is not to say that the AEC abandoned development of megaton-class thermonuclear weapons. Quite the contrary, the AEC continued these programs, even as it observed a presidentially-imposed, yet informal yield limit. Combined with the "fallout budget" first applied to REDWING, this contingency tended to favor work on multiple tactical weapons designs in test series priority, while the fallout budget acted to constrain the testing of higher yield weapons.

some 17,000 square miles of ocean, dusting another Japanese trawler, but not as badly as *Lucky Dragon*. Interestingly, having learned from that experience some Japanese fisherman equipped their vessels with Geiger counters; the captain of the *Mizuho Maru*, after observing the flash of CHEROKEE's unannounced detonation at a distance, began taking measurements that soon revealed they were under bombardment by fallout. The rapid spread of radiation monitoring instruments into the hands of ordinary people did not go unnoticed by the AEC, as Willard Libby implicitly noted such efforts amounted to a poor man's AFOAT-1.

> We have learned from the Japanese that they can follow every bomb we fired in REDWING. [778]

Such uncleared, unsupervised, and unscripted fallout observations presented a far thornier problem than the mere presence a of a handful of journalists at the AEC's dog-and-pony show, especially given the effort put into projecting a positive public image of U.S. efforts to clean up nuclear weapons at REDWING.[779]

The Costs of Military Utility and the Fallout "Budget"

The argument over what to say about ZUNI and the tests of other "clean" designs at REDWING boiled over in the middle of the fallout-limited test series. On 3 July 1956, AEC Commissioner Thomas Murray wrote directly to Eisenhower to object to the Air Force's updated military requirement for a 60 megaton weapon.[780] Shaped by the moral anxieties that framed much of his service on the Commission, Murray again asked a pointed, far more practical question, one undoubtedly already in Eisenhower's thoughts as a retired commanding general.

> Is a weapon of this size necessary or useful for military purposes?[781]

Murray repeated his call for an explicit upper limit on weapon yield, noting his fellow commissioners refused to pursue the issue. Strauss hit the roof upon hearing of Murray's letter, arguing the 60 megaton weapon was only a "feasibility study" and that the AEC had "no firm requirement from the Pentagon" for the weapon. Less than two weeks later, Eisenhower ordered

---

[778] Hansen, *Swords of Armageddon*, IV-164-166

[779] Wary of the need to present its case for the necessity and safety of nuclear testing after CASTLE BRAVO, the United States government debated access for U.S. and foreign journalists, as well as military observers, for months prior to the test. After tentatively announcing a plan to allow fifteen American journalists to observe one shot, ultimately, just four were permitted to report. March-April 1956, White House Office, National Security Council Staff, Operations Coordinating Board Central Files, Box 9, Eisenhower Library; "News Men Will See Next H-Bomb Test," *New York Times*, 3 April 1956; Marvin Miles, "Times Man Eyewitness Story of H-Bomb Drop," *Los Angeles Times*, 21 May 1956.

[780] Hansen, *Swords of Armageddon*, IV-198.

[781] Ibid, IV-181

Strauss, Secretary of State Dulles, and Secretary of Defense Wilson to outline a proposal to formally settle the matter as a policy question.[782] Having first pledged after CASTLE BRAVO that the United States would not create higher yield weapons, Eisenhower now wanted to restructure and settle the "in effect" policy to address growing public pressure on the fallout issue.[783]

It was October 1956 before Defense, on behalf of the Air Force, finally replied to the AEC's inquiry on its plans for filing a military requirement for a new high-yield "clean" weapon design. In a statement directly at odds with the AEC's public claims of considerable progress on "clean" weapon designs following REDWING, the Pentagon argued there was not yet enough data on which to even base such a requirement![784] To compensate for the reduction in yield caused by design changes necessary to create "clean" weaponry, design parameters for a proposed 60 megaton weapon design were apparently driven by a desire to compensate for reduced yield by creating higher yield thermonuclear weapons to serve as their basis. From the Air Force's point of view, creating a 60 megaton weapon did not seem so extreme if its yield was destined to undergo a dramatic downward adjustment to make it "clean." One example of the effects of these design changes was the Mk 36, developed in both a 19 megaton dirty version and a 9 megaton "clean" variant.[785] Weapons with such high yields nonetheless created considerable volumes of fallout, even if in lower proportion to its total explosive force than a standard design weapon. They also did little to change the calculus of cumulative fallout damage likely to be inflicted in a general nuclear war, given the large and growing numbers of weapons anticipated in SAC war plans.

Air Force demand for higher yield weapons after 1954 served as a compensating factor to make up for yield lost to "cleaning" up these weapons, making hollow the AEC's boast of

---

782 "Memorandum dated July 18, 1956 for the Secretary of State, et al., from James S. Lay, Jr., Executive Secretary, Subject: Policy on Stockpiling Very Large Thermonuclear Weapons;" cited in Hansen, *Swords of Armageddon*, IV-200.

783 Ibid, IV-206; Quoted from *New York Times* 7 April 1954 and cited in letter dated November 3, 1956 to Hunter H. Morrison, Robson Construction Company, from Senator Clinton P. Anderson, Chairman, JCAE.

784 Ibid, IV-224.

785 Ibid, IV-244, V-383-396. The Mk 36 replaced the Mk 17 and Mk 21 (both retired or converted to other weapons by late 1957) as the highest yield gravity bomb in the U.S. stockpile. Some 940 were produced, with the last being retired in January 1962. This retirement resulted in an almost 50% reduction in total U.S. stockpile megatonnage. The short life and early retirement of all three weapons was not entirely altruistic, but was largely due to their bulk. Carriage of this weapon was limited to the B-36 (retired early 1959) and the B-47 could only carry the scaled-down Mk 21 if a fuel tank was removed from the bomb bay, sharply limiting the aircraft's range. The B-52s configured to carry a single Mk 36 were reconfigured to carry four one megaton Mk 28 bombs, allowing it to attack four targets instead of a single target.

progress in advance of the 1958 HARDTACK test series, an assertion repeated in the AEC's January 1958 semi-annual report.[786] The general lack of enthusiasm for such weapon designs across the Potomac from the White House and the "don't call us, we'll call you" nature of the military's reply to the inquiry about pending requirements for "clean" weapons was a signal to the AEC it, too, should focus most of its efforts on developing standard nuclear weapon designs.

High Hopes

Most responsible for an impulse of false optimism among the national security bureaucracy following REDWING was NAVAJO, as its test proved the feasibility of a two-stage thermonuclear "clean" weapon design. A high percentage of fission reduction was only possible with high yield weapons, yet it failed to substantially alter the cumulative risk posed by wartime fallout. As tested, the 4.5 megaton NAVAJO shot (10 July 1956) nonetheless generated fallout equivalent to a 200 kiloton fission weapon.[787] Utilizing a modified version of the same primary design used at CASTLE BRAVO, NAVAJO was the "cleanest" U.S. shot ever, achieving 95% of its yield from fusion. Nonetheless, 50% of its fission product yield came down as fallout over some 14,000 square miles. Chuck Hansen noted the high percentage of yield from fusion with NAVAJO was often cited by proponents of "clean" weapons as demonstrating the success of this approach to fallout reduction.[788] Instead, the results clearly disputed the public assertion of an anonymous source inside the AEC who claimed with the new "clean" design the "H-Bomb Proved Itself 'Sanitary.'"[789] Left unsaid was the 14,000 square miles of ocean impacted by NAVAJO's fallout plume remained a daunting level of contamination. While NAVAJO may have been "cleaner," it was hardly "sanitary."

Fallout reduction came at a cost in military utility, with increased weight versus yield ratios. A significant factor here was anticipation of guided missile delivery systems, which were designed around fairly narrow limits on available throw weight to range. Prior to NAVAJO, REDWING also brought the first successful fission test device from Livermore, no doubt a relief

---

786 Hansen, *Swords of Armageddon*, IV-244.
787 Ibid, IV-76.
788 Ibid, IV-182-183.
789 "H-Bomb Proved Itself as 'Sanitary,'" *Los Angeles Times*, 23 May 1956.

to both Teller and his Air Force sponsors after three previous failures at UPSHOT/KNOTHOLE and CASTLE.[790]

While the "fallout budget" constrained the scope and pace of testing at REDWING in the Pacific, fallout was a more direct threat to testing in Nevada. In order to limit continental testing at NTS, some lower yield shots that might have waited for the next series there were instead shifted to the Pacific Proving Grounds (PPG) in the 1956 REDWING test series schedule. At the PPG, the shuffle of "musical bombs" continued as the limits imposed by fallout created additional inconveniences in an already meticulously complex test process. The main support base for PPG was located on the Eniwetok atoll. Given the results of CASTLE, it was decided that future high yield shots would take place only at the medium distant (~200 miles), but downwind, Bikini atoll. Lower yield shots were conducted at Eniwetok, where their relatively less threatening fallout plumes were much less likely to contaminate the PPG support facilities.[791] Although the shift helped protect testing activities and facilities, placing the high yield shots at Bikini moved them significantly closer to the populated islands of Rongerik and Rongelap. Given the islands' political status as a trust territory, this decision was seen as effectively shielding Americans from dirty work they were unwilling to do on their own territory, shifting it instead onto the lands of others they were ostensibly charged with protecting, heightening their risk and burdens instead.[792] In the context of the Soviet Union confining testing, if not fallout, to its own territory, many saw these decisions as an American abuse of its trust territory responsibilities, complicating already complex political comparisons between the East and West across vast swathes of the rapidly decolonizing postwar world.

REDWING proceeded with every indication fallout was not only unconquered, but a problem whose scope was not yet fully appreciated. On 9 July 1956, the APACHE shot (1.8

[790] Hansen, *Swords of Armageddon*, IV-100. The irony of UCRL's first success was that it was the relatively puny 7 kiloton TESLA shot, at the opposite end of the yield range that the Air Force used to rationalize creation of the Livermore weapons laboratory.

[791] Hansen, *Swords of Armageddon*, IV-144-145.

[792] The Pacific Proving Ground involved lands and waters that were part of a United Nations Trust Territory that was administered by the United States, eventually becoming known as the Marshall Islands. The U.S. High Commissioner created an uproar after revealing that some of the displaced residents might never go home due to contamination from testing. Pierre J. Huss, "May Ban Life On H-Bomb Test Isles," *Daily Defender* (Chicago), 20 June 1956; The U.S. government responded to United Nations member inquiries by claiming the presence of the test party proved the islands were livable, although noting that radioactivity made a permanent return impossible. "Atomic Test Atolls Still Inhabitable, Officials Say," *Los Angeles Times*, 21 June 1956; The United States claimed that such use was permitted under Trusteeship Agreement of 1947. "U.S. Denies Tests Misuse Trust Area," New York Times, 28 June 1956. The issue would linger, eventually forcing the United States to rely on British cooperation to use their possession, Christmas Islands, for its last high-yield test atmospheric test series in 1962.

megaton) yielded heavy fallout. The TEWA (5 megatons, 20 July 1956) shot followed later that summer, a “dirty” version of ZUNI (3.5 megatons, 27 May 1956). TEWA produced 87% of its yield from fission, spreading 28% of its fallout over 57,000 square miles, with a particularly intense area of 120 square miles receiving fallout at a rate of 2,500 roentgen/hour; readings above 100 roentgen/hour contaminated a further 7,100 square miles.[793] Most of the rest of TEWA’s fallout was injected into the stratosphere, although at the time of REDWING, many still believed this radiation simply disappeared through a yet to be understood process of atmospheric dilution.

Mr. Strauss, We Have a Security Leak…It May be a Good Thing

One problematic feature of radiochemical analysis of fallout was procedures so useful in providing a detailed analysis of fission weapons were not so all inclusively tell-tale in revealing the workings of thermonuclear weapons, for example in discerning the relative proportions contributed by the primary and secondary to total yield.[794] Reacting to prepared statements by the AEC, apparently seeking to take advantage of good news on developments in “clean” weapon designs to bolster Eisenhower’s chances for reelection as he ran against Adlai Stevenson’s promise to end fallout from testing, Edward Teller blasted the idea of revealing that ZUNI was a “clean” design, in the somewhat naïve belief that pointing this out for political advantage would help the Russians calculate that most of its 3.5 megaton yield came from fusion. While the Russian program lagged behind that of the U.S. in several areas, evidence of ZUNI’s yield might instead make them wonder what wasteful path the Americans had stumbled upon. Teller’s personal appeal on the matter persuaded General Alfred D. Starbird, AEC Director of Military Application, to support Teller’s position. Whether he believed Teller or simply wanted to placate him was unclear. However, in advising AEC Chair Strauss of the matter, Starbird took a more ambivalent turn, arguing that it might actually be a good idea if the Russians did learn something about American developments in “clean” designs then underway by the United States.[795]

---

[793] Hansen, *Swords of Armageddon*, IV-183-184.

[794] In thermonuclear weapons, the primary stage is always a fission device of some kind, needed to generate the extreme temperatures and pressures that radiated to initiate the fusion secondary. While some speculated means could eventually be found to initiate a secondary fusion reaction without the need for a fission reaction, the high temperatures and pressures needed appear to preclude any other plausible scenario in a form that could serve as a weapon.

[795] Hansen, *Swords of Armageddon*, IV-168.

Starbird's point of view was obviously that of a man who presumed the Russians were watching American tests as closely as Americans watched Russian tests. Given his technical responsibilities in coordinating various test operations, he was familiar with the basic concepts of long range detection, if perhaps not privy to all the details. As an AEC representative formulating arms control policy positions in the years after 1956, he later closely worked with Doyle Northrup and others representing AFOAT-1. It was clear from the archival record Starbird was generally cognizant of the unit's intelligence work during REDWING. In fact, AFOAT-1 was consulted on their opinion of Teller's concerns about revealing ZUNI was a "clean" design might aid the Russians.[796] Certainly Starbird's comments in the letter to Strauss conveyed a basic understanding that fallout compromised bomb design information, again confirming AEC leadership knew then, if it did not realize in some form or fashion before, that every atmospheric test it conducted potentially revealed far more design information than multiple Soviet human agents planted within the AEC might be able to do. The Air Force certainly understood from the time of the development work to put AFOAT-1 in operation that its techniques could just as easily be used against American testing as against the Russians. This factor was a large part of the reason for worries expressed over Japanese fishermen acquiring the capability to measure fallout. While fallout was born in secrecy, it was a perishable secret, one that by 1956 showed every indication of unraveling. This contingency became another factor driving AFOAT-1 to develop new long range detection technologies, particularly improving seismic detection capabilities in anticipation testing, for a variety of empirical reasons largely related to fallout, would eventually move underground.[797] On balance ending what was potentially lost on the

[796] Hansen, *Swords of Armageddon*, IV-173-174.

[797] Seismic detection, as with fallout sampling and the other techniques of LRD developed by AFOAT-1, were all originally intended for intelligence collection and designed with that in mind. Adaptation to verification was fairly straightforward technically, but organizationally that was a different matter. Jack Evernden noted that in the mid-60s the JCS admitted in an internal document they intentionally used the "lack of seismological understanding as a pretext for opposing" a comprehensive test ban treaty, which throws new light on the nature of their support for the LTBT as a substitute. Jack F. Evernden, "Lies That Stopped a Test Ban," *Bulletin of the Atomic Scientists*, Vol. 44, No. 8 (October 1988), 20-24. In an oral history interview with Kai-Henrik Barth, Charles B. Archambeau credits DOD funding of the VELA research and development program with supporting his cohort of students. "His [1959 entry] was one of the largest classes to arrive at Caltech in geophysics; most of his colleagues agreed that if not for Vela and the money that came in, they would not have gotten an education at that level…the whole graduate career was as research associates working on problems that were of interest to the DOD and CIA and others…" Interview of Charles Archambeau by Kai-Henrik Barth on 1998 July 24, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/5899. Another 1998 Barth interview with Bryan L. Isacks noted that "when big money from Department of Defense begins to flow" in 1959, Columbia University's Lamont Geological Observatory built a new main building, a new seismology building, and he more or less drew a regular paycheck as a grad student. Interview of Bryan Isacks by Kai-Henrik

winds, if for no other reason, would contribute to ending fallout as the security risk it obviously represented.

There was considerable irony in the discussion about whether to publicize a shot as "clean," aside from toying with a paranoid like Strauss over how loyalty and nuclear secrecy were compromised every time a nuclear device was tested in the atmosphere. It was remarkable an American general seemingly wanted to ease the burdens his Russian peers might place on those they targeted by suggesting that it might be useful for them to surreptitiously discover American "clean" weapon designs by means of fallout analysis. This almost put the Russians in the same position as the British in gaining a legal dodge around the Atomic Energy Act of 1954, which narrowed the limited cooperation the Atomic Energy Act of 1946 (or McMahon Act) provided with Britain and Canada, although one presumes the Russians would not be tipped off about the timing or details nor invited to send representatives and observers, as the British were.[798] As an engineer, it was not surprising that Starbird regarded fallout as a technical problem, rather than a fundamental strategic one that undercut the premise nuclear weaponry provided a means to achieve security. Starbird's premise of the potential beneficial aspects of "clean" weapon designs and other actions suggest as late as 1956 he still considered fallout a minor, manageable design problem, rather than the irresolvable Achilles heel of nuclear weapons it was shaping up to be. Starbird's was a widely shared view. In an eerie way, this "patience, it will all work out" approach to eliminating fallout as a problem in the latter half of the nineteen-fifties had interesting parallels to the immediate postwar fallout belief system suggesting fallout made nuclear tests trivially easy to detect.[799] The memo clearly demonstrated the Pentagon and the AEC were mutually aware of the general security problem fallout represented.

Described by one colleague as "the ultimate manager," Starbird was the Pentagon's primary advocate and representative inside the AEC, with lengthy experience and the respect of

---

Barth on 1998 June 9, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/5901. The situation seemed best summed up by the cliché "if you want to kill an idea in Washington, you study it."

[798] Several early cases involving Soviet spies under British cover, including Klaus Fuchs and Kim Philby, shaped restrictions on sharing nuclear information with close allies Canada and the United Kingdom, which were codified in the various iterations of the Atomic Energy Act of 1946, later amended to the Atomic Energy Act of 1954. By 1958, the 1954 Act was again amended to facilitate better cooperation with the British.

[799] Ziegler and Jacobson, *Spying without Spies*, 51-52,720-74. This belief regarding the ease with which fallout could be exploited was a mistaken notion discussed at several points in the pioneering study of AFOAT-1 by Ziegler and Jacobson. General LeMay and Lewis Strauss were among the influential believers in the ease with which this could be accomplished.

his technical and scientific peers. A West Pointer and 1936 Olympics Gold Medalist in the pentathlon, Starbird came upon his ultimate career path beginning with his participation in SANDSTONE in 1948. After subsequent assignments outside the nuclear field, Starbird served as director of Military Applications at the AEC from 1955 to 1961, during which he was deeply involved in "developing Atomic Energy Commission positions on U.S. disarmament proposals to control nuclear weaponry." Later, after the resumption of atmospheric testing by the Soviets in 1961, Starbird was recalled from another assignment and tasked with directing what became the last U.S. Pacific atmospheric test series, DOMINIC, in 1962.[800] In that capacity, he managed creation of more fallout than any other American, making his dour comments especially piquant.

Coming "Clean" about Fallout and Long Range Detection

At the 1956 REDWING test series, the argument "clean" weapons were an answer to the fallout problem came into uneasy juxtaposition with the belief that simply shifting military strategy to emphasize use of low-yield tactical weapons was sufficient. Interestingly, General Starbird clearly indicated these points conflicted in describing how "clean" weapons required more fissile material than standard designs did and sharp limits about how they could be employed, in addition to facing physical limits on how small a yield such a "clean" weapon could have and still sustain a fission reaction.[801] More testing was required, but Starbird's description demonstrated he understood the complexities of what seemed reasonable to the uninitiated, but which in fact directed the AEC towards conflicting goals.[802]

The U.S. military's overall shift in thinking to embrace very low yield nuclear weapons also presented a problem affecting formulation of arms control verification proposals. Projecting its own interest in weapons with yields of less than five kilotons onto the Soviets, the Pentagon shifted to framing its concerns about use of the AEDS for arms control purposes to an expectation that any monitoring or verification system must detect all such tests and differentiate these relatively weak signals from noise and natural geologic vibrations.[803] The problem was that

[800] John S. Foster, "Memorial Tribute to Alfred D. Starbird," *Memorial Tributes, National Academy of Engineering*, Vol. 3 (1989), 316-321, http://www.nap.edu/openbook.php?record_id=1384&page=316,
[801] Hansen, *Swords of Armageddon*, IV-169-171.
[802] General Starbird of the Army Corps of Engineers became the preeminent director of American testing in the last decade before the practice ended in 1963. A memorial to his work provided substantial background. Foster, "Alfred Dodd Starbird, 1912-1983," in *Memorial Tributes*, 316-321, http://www.nap.edu/read/1384/chapter/55.
[803] Hans Bethe, *The Road from Los Alamos* (New York: American Institute of Physics, 1991), 37-53. Bethe gave a cogent analysis of the detection problems associated with testing, concluding that while there are no absolutes, arms control was both practical and generally reliable. AFOAT-1 turned to Bethe to fill the role that Oppenheimer

all of these faint signals were buried together down in a noise floor of low-level natural and human-induced seismic noise, thus the Pentagon's caveat represented a very difficult, near-absolute standard to meet in assessing the effectiveness of a verification system. Whether actually intended as a rigorously effective standard by which to assess verification technology or simply as an implicit poison pill to block signature of any diplomatic arms control agreement, in effect this extraordinary requirement for unprecedented accuracy asserted an implicit Pentagon veto on arms control policy.

Trying to Dodge Fallout's "High Yield" Problem

Discussions between the Pentagon and the AEC on new military requirements came to a head in early 1957 as inter-service rivalries stirred up by BUDAPEST apparently added to the complexities of determining future weapons production schedules.[804] In one of the rare instances when a light shone into the inner sanctum of Joint Chiefs of Staff deliberations on nuclear strategy in a timely manner, a letter from a somewhat anonymous informant with direct access to the JCS wrote to AEC Chair Lewis Strauss, summarizing discussion among the chiefs about pending requirements for the 60 megaton weapon.[805] In part, the letter specifically addressed Commissioner Murray's complaints about stockpile composition and his desire to shift away from high-yield weapons because of the threat posed by their massive fallout.

With one eye on congressional and public opinion, the author assessed the JCS would likely conclude they preferred to not issue a formal military requirement for a high yield "clean" weapon. They then noted Eisenhower's request that the Secretaries of State and Defense, along with Strauss, advise the president on a response to Murray's letter, with the author arguing that while the president believed "no sound military requirement exists (for such a weapon)," he apparently acceded to the idea that "small numbers" of a very high yield weapon should be produced as a "desperation, disaster weapon for last-ditch use." However, the arrangements to

---

occupied until Joe-1 as primary technical advisor and chair of a panel cited as "the definitive voice on Soviet explosive devices." AFTAC, *A 50 Year Commemorative History*, 28.

[804] See page 345. BUDAPEST was a Pentagon study of the effects, including fallout, of Air Force use of high yield weapons on the operations of the other military services during war.

[805] Letter dated February 13, 1957 to AEC Chairman Lewis Strauss with attachment dated February 14, 1957; cited in Hansen, *Swords of Armageddon*, IV-248-251. The letter and its attachment were apparently found amongst declassified copies of Strauss's correspondence. Self-identified in the letter as the chief of "General (Lauris) Norstad's Atomic Planning Branch within his Air Operations Directorate" for three-and-a-half years sometime prior to 1957, the author was apparently a high ranking military aide subsequently assigned to the JCS – and an informant on their work to the extent of drafting lengthy memos to Strauss. Further research is needed to identify this officer, but that is likely possible.

produce it should be made in such a way as to "preserve deniability that any such requirement existed…"[806] While clearly a political dodge, it was another sign despite their expressions of public confidence on the issue, fallout was increasingly constraining the choices available to policy makers. Interestingly, the memo's author laid out what he saw as the problem driving the whole issue. Generals, who knew little about nuclear matters, were advised by lower ranking officers who lacked guidance due to what was a policy of "in effect:"

> Another major handicap lies in our National Policy (sic) which establishes no specific war objectives from which the military can deduce any limitation on the destruction to be inflicted on the enemy. Consequently, no limitations are planned.[807]

Alarmingly for its still-anonymous author, the lack of apparent constraints demonstrated how the few who understood the implications of fallout for the military utility of nuclear weapons were shocked at the continued resistance within the Air Force to coming to terms with that reality. In its enthusiasm for airpower, General LeMay himself could have written the memo. The sentiment of revulsion at the wanton excess of SAC's war plans was an indication the author's view was widespread in the military, in uneasy juxtaposition to others like LeMay who believed war without limits enabled by the tenets of nuclear absolutism was the only prescription possible in the nuclear age. The only way to avoid nuclear destruction seemed to be to destroy the opponent first before he could launch his bombers or missiles. Once fallout was factored in, however, it was recognized this would be a suicidal act, even if Russian retaliation could be cut short by a quick victory. How could the president explain "winning" such a war and what would that "victory" look like?

After discussing the rather arbitrary math of the target planners' calculations for a requirement to expend 110 megatons in an effort to ensure 90% probability of destruction of a single airfield, Strauss's correspondent expressed his dismay at the purposeful ignorance about fallout on display in secret.

> When SAC calls for high probability of cratering runways, with high CEP [circular error probability], the yield required for single-weapon attack is not only high, but the weapon must be ground burst. Fall-out from such attacks has been

[806] Letter dated February 13, 1957 to AEC Chairman Lewis Strauss with attachment dated February 14, 1957; cited in Hansen, *Swords of Armageddon*, IV-248-251.
[807] Ibid.

> largely ignored to date by all planners except SACEUR (Supreme Allied Commander, Europe) who prohibits ground bursts.[808]

In a nutshell, concerns about developing "clean" weapon designs were wholly beside the point if they were used in such a fashion; given the yields involved and a zero height of burst; under such a targeting scheme, fallout would be massive regardless of the weapon design. Citing his breadth of experience in Europe, the author noted that it was only under General Lauris Norstad as Supreme Allied Commander Europe (SACEUR) that any of the Air Force commands considered fallout as a factor in what he called a "stone age" approach to developing military requirements for nuclear weapons.[809] Acknowledging Murray might just have a point, he also rebelled at the notion Murray's "guesses" should substitute for those which he acknowledged the military planners were also routinely making.[810] If it was possible, the "goddamnedest thing" grew incrementally more damning. The insights offered by Strauss' anonymous informant spoke to the likelihood the routine marginalization of consideration being given to the multiple perils of fallout pre-existed the anonymous officer's experience, a policy that represented continuity over change over the bulk of the nineteen-fifties.

Strauss Flips on Delivering "Clean," Runs out of Others to Blame under Gathering Clouds

Despite these obviously mixed, even pessimistic results from REDWING on "clean" and "dirty" weapon design, Strauss issued a statement on behalf of the AEC on 19 July 1956 conforming to the official theme of the test series, while conveniently ignoring the factual results. Rarely one to avoid stirring the pot of controversy further, Strauss argued that the test series heralded the arrival of a new era of "humanitarian" weapon designs. Strauss claimed the results of REDWING meant "mass hazard from fallout is not a necessary complement to the use of large nuclear weapons."[811] Congress was increasingly skeptical of Strauss's claims. U.S. Representative Chet Holifield rather presciently noted Strauss lacked credibility.

---

[808] Letter dated February 13, 1957 to AEC Chairman Lewis Strauss with attachment dated February 14, 1957; cited in Hansen, *Swords of Armageddon*, IV-248-251.
[809] Keep in mind that General Norstad was both the original architect of the Air Force's strategic war plans and among those lobbied by the Air Force over the briefing of SACEUR Dwight Eisenhower on the findings by the VISTA study group because of Robert Oppenheimer's participation. Norstad served as SACEUR from November 1956 to January 1963. His position on fallout was an early indication that LeMay's policy of ignoring it would eventually prove to be less than hegemonic among Air Force leadership.
[810] Letter dated February 13, 1957 to AEC Chairman Lewis Strauss with attachment dated February 14, 1957; cited in Hansen, *Swords of Armageddon*, IV-248-251.
[811] Hansen, *Swords of Armageddon*, IV-189. The AEC, in coordination with other executive branch agencies, made a coordinated effort to portray the first high-yield test series since CASTLE as overcoming the problems BRAVO

Huckstering is no substitute for policy as we grope for solutions to the atomic and hydrogen dilemma.[812]

Eisenhower was no more impressed than Congress; in fact, he ducked the fallout storm Strauss stirred by refusing to issue a Strauss-prepared statement claiming advances made at REDWING "resulted in only a fraction of the fallout experienced in our previous Pacific tests," ostensibly because the president did not want to take questions that might be raised by bringing up the subject.[813] Whether fallout or Strauss's personal faults lay at the root of Ike's growing mistrust of Strauss's advice mattered little at this point. Strauss was more effective in the role of lightning rod than as the barn it protected, a dangerous situation for a presidential appointee with a controversial agenda to enact.[814] Strauss either obviously did not understand the cumulative nature of fallout, if he still believed it did not represent a "mass hazard" in wartime, or his statement was as cynical as his persecution of Oppenheimer. The threat of a "mass hazard" created by fallout clearly was before Eisenhower – and he wanted to change the subject in public, not deal with inconvenient candor.

Discretely pointing out his own intimate relationship with the intelligence uses of fallout, AEC Commissioner Willard Libby also opposed confirming the United States could alter production of fallout by means of weapon design. Libby's concerns centered on how such a statement could be used in concert with radiochemical analysis of fallout to infer restricted data about weapon design. Libby frankly acknowledged "a series of events" had forced the AEC's hands on the matter of being seen to do something about fallout, the most significant being the inadvertent release of top secret testimony by Army Lieutenant General James Gavin in late May 1956 in the middle of REDWING.[815] Fallout's capacity to extend its political effects outside the

---

called to public attention. This included issuing a statement immediately after the opening thermonuclear test (CHEROKEE, 20 May 1956, 3.8 megatons) declaring it radiologically "sanitary." "H-Bomb Proved Itself 'Sanitary,' Officials Say," *Los Angeles Times*, 23 May 1956.

[812] Hansen, *Swords of Armageddon*, IV-189

[813] Ibid.

[814] Greene, *Eisenhower, Science Advice*, 132-133. Strauss seemed to be aware of the potential for missteps with nuclear weapons policy, but was among those close to Eisenhower who sandbagged Harold Stassen's efforts to breathe life into arms control diplomacy. Stassen left in early 1958, but Strauss's chairmanship of the AEC, too, came to a close within months, as Eisenhower refocused on a closer relationship of science to policy, suggesting the rising importance of empirical factors in national security policy over purely political or diplomatic ones.

[815] See page 307-308. Gavin's May testimony that a nuclear war would result in "several hundred millions deaths" from fallout was made public on 28 June in what Senator Henry M. "Scoop" Jackson called a "blunder." The headline was lop-sided, the alarm in the article more universal. Willard Edwards, "Reveals Bombs Could Wipe Out Russ Millions," *Chicago Tribune,* 29 June 1956.

hermetically-sealed world of national security drastically turned up the pressure for the AEC to act. Much was at stake.

> Mr. Libby said that if the proposed statement were made, it was possible that it would ultimately lead to warfare with radiological weapons or that the DOD would be forced to stockpile only "clean" weapons. The commissioners then discussed whether public opinion might force the DOD to such a step.[816]

Strauss then insisted that the world needed the reassurance of a statement that the United States was committed to achieve a "clean" weapon design in order "to reduce pressure for the cessation of weapons tests." In the end, Libby dropped his own previous opposition to such a statement, arguing it was necessary this time, but must be coordinated closely with the Pentagon and the entire government to be persuasive. Essentially, fallout was at this point ironically forcing the secret of "clean" weapons into the open despite significant opposition to releasing information about them, largely because public opinion about fallout and its unavoidable connection to any nuclear explosion in the atmosphere, which could be exploited in the same manner as the United States did, created nearly irresistible political pressures for government to be seen as acting to limit it. However, to suggest this was fully a product of social actors ignores the vital role of fallout's capacity to insinuate itself and force the hands of social actors despite human evasion and resistance. Even in simply being avoided, whether in the public statements of the president, the classified memos of an AEC commissioner, or the myriad of other ways something secret like fallout became an uncomfortable subject of public discussion, it played a powerful role as a material actor among and within networks of human actors.

Conventionalization: 1956: Throwing the Bones

> ….the United States appears to be gambling, as far as civil defense is concerned, that there will not be a war.[817]

In the midst of the slowly percolating public uproar over fallout, the Joint Chiefs of Staff sat down to what Campbell Craig called "the richest NSC meeting on nuclear strategy during the entire Eisenhower era" on 27 February 1956. Focusing on the annual basic national security policy review, JCS Chair Admiral Arthur M. Radford pitched inclusion of more comprehensive language on the terms of engagement of nuclear weapons in order to address their pervasive

---

[816] Commission Discussions of Public Statement of Reduced Fallout Weapons, attachment to Memorandum for the Chairman dated July 21, 1956 from W. B. McCool, Secretary, 13-16; cited in Hansen, *Swords of Armageddon*, IV-189-191.

[817] Brig. General (retired) Thomas R. Phillips, "Civil Defense," *Air Force*, V. 38, No. 10 (October 1955), 60-61.

presence in frontline military units. Radford essentially asked for authority to implement the same rules of engagement for tactical nuclear weapons as applied to conventional weapons when designated for defensive purposes.[818] Here Radford invoked the basic principle of nuclear absolutism, arguing that the only effective answer to a nuclear threat was a nuclear defense

The prospect alarmed the president, given his fear of rapid escalation into general nuclear war such an incident could precipitate. The Joint Chiefs of Staff pushed for the formal change of language to provide greater flexibility for the use of tactical nuclear weapons under circumstances other than general war; the JCS also requested more incremental options be added to the Strategic Air Command's massive retaliation war plans. In part due to pressure from European allies simultaneously fearful of stopping a potential Russian attack and the use of American thermonuclear weapons to do so with resulting fallout, Secretary of State Dulles endorsed this clarification, already enshrined in policy as NSC-5602/1.[819] In fact, the two initiatives worked somewhat at cross purposes, given the Europeans were just as alarmed as Eisenhower about the potential for an American officer to start a nuclear war with a loosely-controlled tactical weapon.

Reflecting the pitch by Admiral Radford, the apparent goal of the significant policy shift toward tactical nuclear weapons underway at the Pentagon was part of a wider effort on the part of the JCS to effectively *conventionalize* the use of nuclear weapons. The remedy to the perceived lack of utility of high yield thermonuclear weapons due to their massive fallout was to

---

[818] Craig, *Destroying the Village*, 55-59, 63. From Memorandum of Discussion at the 278th Meeting of the National Security Council, Washington, March 1, 1956. Craig's argument was lengthy and complex, but convincing. Admiral Radford was clearly asking for the authority to treat tactical nuclear weapons the same as conventional weapons. This would have short circuited the existing authorization process, which required presidential authority to expend nuclear weapons, much as it remains today. Radford's argument was that there might not be enough time to notify the president for permission to repel an attack, given faster airplanes and the near-term prospect of missile attack. On the other hand, Eisenhower feared the possibility that a junior officer might fire the first shot and drag the US into a nuclear war.

[819] Ibid. NSC-5602/1 was the basic national security plan for 1956. The final result of Eisenhower's back and forth with his NSC advisors summarized the president's belief there should be no distinction between general and peripheral war, given the tendency for military escalation aggravated by the availability of nuclear weapons. In a memorandum dated March 15 to the Secretary of State, Secretary of Defense, and the Chairman of the Atomic Energy Commission, Executive Secretary Lay stated that the President, taking note of a memorandum from the Joint Chiefs of Staff to the Secretary of Defense entitled "Presidential Authorization for the Use of Atomic Weapons," dated February 15, approved paragraph 11 of NSC 5602/1, with the addition of a final sentence. The paragraph, as approved, reads as follows: "It is the policy of the United States to integrate nuclear weapons with other weapons in the arsenal of the United States. Nuclear weapons will be used in general war and in military operations short of general war as authorized by the President. Such authorization as may be given in advance will be determined by the President." Eisenhower Library, Special Assistant for National Security Affairs, Records, Presidential Approval–Atomic Energy, https://history.state.gov/historicaldocuments/frus1955-57v19/d62#fn9.

embrace weapons with significantly less fallout simply by virtue of their limited yield, ironically, yet fortuitously present and scheduled to soon be ready for action in the U.S. stockpile thanks to the legacy of Robert Oppenheimer's prior leadership of the AEC's General Advisory Committee. In Europe, fallout contributed to a significant shift from a virtually all-SAC Air Force show to one where the Army constituted a significant part of nuclear-equipped forces, with tactical air power now constituting the bulk of frontline air force units. As attractive as the conventionalization solution was to the Pentagon, it perturbed the president as risky business.

Interestingly, despite Eisenhower's fear of surprise attack, the president carefully avoided the question of limited, flexible use of nuclear weapon until the JCS put him on the spot about it in the spring of 1956. Meeting in May with just the four members of the JCS present, Eisenhower's follow-up response to the military's gambit, shaped by Clausewitzian theory, argued armed conflict tends toward general, total war, using "every weapon at hand." Eisenhower felt it highly unlikely the USSR's leaders would resist massive use of any nuclear weapons available to them in the event of nuclear conflict with the United States.[820]

As a West Point graduate, it was unsurprising the president framed his theoretical orientation with the aid of Clausewitz; more significant was his expansion and refashioning of Clausewitz to the demands of the nuclear age. Eisenhower adapted Clausewitz by arguing for a utilitarian approach to war in the nuclear age, recognizing weapons technology was inextricably interwoven with the ideological, social, and political relationships of total war.

Eisenhower's innovation centered on realization the effects of nuclear weapons, most significantly of all their fallout, put not just the state at risk, but society itself. Fallout made the potential costs of nuclear war too high to profit from in any sense in all but the most exceptional cases; even then, success remained dubious and depended on a redefinition of victory as something very different from any war ever undertaken. Here was where fallout played a major role in prompting Eisenhower to recognize nuclear weapons created a stalemate, as Campbell Craig related in detail; notably, Craig did not closely connect Eisenhower's innovation to the problem of fallout as decisive, rather invoking the supraconventional effects of physical destruction as the basis of Ike's belief.[821] The result was a military strategy dependent on the

[820] Craig, *Destroying the Village*, 60-61.
[821] Ibid, 68-69.

deterrent effects of nuclear weapons, rather than on their use, as the only viable outcome to the Cold War confrontation.

Shattered Victory

Despite the growing effort to refashion discourse in support of fallout, leaks and subsequent declassifications provided evidence the debate about the utility of nuclear weapons was far from settled. What did General Gavin's testimony suggest about the increasingly controversial nature of fallout within the government and the military? At the 25 May 1956 closed hearing by the Senate Subcommittee on the Air Force, Gavin, the Army's Director of Research and Development, testified about the toll fallout would impose on the *victors* were the United States to prevail in a nuclear war against the Soviets. While it was unclear exactly how Gavin's testimony was printed and inadvertently released just over a month later, its sensitivity was crystal clear given the release's timing during the REDWING series.[822] Gavin stated it was estimated "deadly radioactive fallout" would kill "hundreds of millions of people, including a great many in friendly countries…in an all-out Air Force attack on the Soviet Union." Unlike much informed and uninformed opinion on the matter, Gavin specifically noted that the numbers he quoted were drawn from current planning documents, essentially what the Pentagon's agenda was for tomorrow if war were to suddenly begin. General Gavin strongly suggested the Air Force should give its own account of the problem.[823] Given the interval since CASTLE BRAVO and the SAC's substantial lack of attention to the matter of fallout except for intelligence purposes in the interim, the plans Gavin referred to were based on extrapolations from the threat posed by the cumulative fallout generated in accord with the level of anticipated Air Force strikes against Soviet targets. While Gavin did not use the word "goddamnedest," his suggestion that the Air Force should offer its own account of the matter seemed to distinguish between what he reported in confidence and what the Army supported in public. Ultimately, the lack of further direct comment on the matter largely buried its import.

The dispute pointed out the role of fallout in heightening inter-service rivalry, which was a factor in the hearings held in late May 1956. Secretary of Defense Wilson described Eisenhower as "a bit vexed" about the squabbling over the roles and responsibilities of various

[822] REDWING began with LACROSSE (4 May 1956, 40 kilotons) and ended seventeen shots later with HURON (21 July 1956, 250 kilotons).
[823] "Army Fails to Bar Bomb Testimony," *New York Times*, 29 June 1956.

weapons systems each service favored.[824] At its root was a growing clamor from the Army and Navy for their own arsenal of tactical weapons, even as fallout placed limits on the Air Force's acquisition of the high yield weapons it had fought so tenaciously for just a few years earlier.[825] Having failed to make its case for a virtual monopoly priority on fissile material for SAC, but winning the battle against Oppenheimer, the Air Force then lost the war on high-yield weapons and found itself thrown into more direct competition with the other services for the vast, but still finite nuclear resources provided by the AEC.[826] Army and Navy capacity to begin fielding a diverse range of tactical weapons systems in 1956 thus was largely made possible by the weapons development legacy of the Oppenheimer-era 1950 GAC.

How fallout impacted the shifting strategic stockpile mix was demonstrated at REDWING by the fact that UCRL shots like INCA, KICKAPOO, and YUMA were more historically significant for being 15 kilotons yield or less than the yield of the second laboratory's first successful thermonuclear shot there was, the 3.5 megaton ZUNI device.[827] The Livermore laboratory, created to focus on creating high-yield strategic weapons for the Air Force, now divided its time to include both "clean" and tactical weapons to address the shifting strategic paradigm created by the forced recognition that fallout was a far more significant threat than originally envisioned. This effort created a frustrating hierarchy of preferences for the Air Force, which having seen its access to desired high-yield weapons limited by fallout, found alternatives, which placed them again in competition with the other services. Both tactical weapons and the questionable quest for "clean" weapons were inherently less "efficient" than SAC would be in their use of fissile material and delivery system capacity. While SAC felt it lacked what it needed, what it possessed was more than enough to deliver a knockout punch to humanity, as well as to any specific opponent.

Despite his assessment that REDWING's results were "spectacular," Chuck Hansen turned uncharacteristically judgmental, given the usually even-handed gaze of his evaluations of

---

[824] Allen Drury, "President Vexed by Service Fight; Inquiries Slated: Wilson, After Talk at White House, Says Eisenhower Is 'a Bit Unhappy,'" *The New York Times*, 23 May 1956.

[825] Each high-yield weapon used enormous quantities of fissile material. Given the latent evidence SAC found its desires limited by the recognition that there were finite limits to tolerable fallout exposures, this allowed reallocation of fissile material production to build many more "right size" strategic weapons, as well as very low yield tactical weapons.

[826] Hansen, *Swords of Armageddon*, IV-202. Despite the continuing clamor from LeMay about SAC being shortchanged, it was a dispute over increasingly substantial resources, with fiscal year 1956 Pu-239 production rose 82% over FY 1955, while production of tritium was up 50% and U-235 up 62%. Also see Appendix B.

[827] Ibid, IV-192.

formerly secret documents. Hansen summed up this relatively brief infatuation with the prospect of discovering a technical fix for fallout bluntly.

> Aside from being an interesting technological challenge, “clean” weapons were primarily just an expensive public relations gimmick.[828]

Certainly, one thing undermining the putative national commitment to reducing fallout at REDWING with “clean” weapons was the work done there in parallel on the development of “salted” weapons to intentionally increase the radiation produced, demonstrating the liminal potential for an even worse public backlash against the nuclear plans of the AEC and Pentagon. It is worth interrogating again Teller’s documented concern about publicly revealing that the ZUNI shot was a “clean” design. Teller’s objection likely centered on the fact such a revelation might identify samples from other shots as being particularly dirty. Given Teller was both cognizant of fallout’s informative potential and already wary of identifying a “clean” shot, it follows almost certainly that he and others were equally concerned about the comparisons that sampling potentially held for every other shot in the series as well.

REDWING was successful in increasing the efficiency of specific U.S. weapons designs, but the overall yield efficiency of 58% from fusion was actually less than CASTLE’s 63% from fusion, the latter statistic driven by the unexpectedly large yield of BRAVO.[829] Even in pursuing research to suppress fallout, the United States government remained conflicted about what national policy was on fallout – having left so much of that to chance over the last decade, other than for intelligence – that it continued to generate fallout at basically the same rate as before it became an issue. If not for the secrecy shielding the nuclear program in general and fallout specifically, the contrast between the claims made and the token results achieved in fallout reduction by the REDWING test series would have been a scandal.

NSC 68 Withers Away with a Whimper, Not a Bang

While the implications of the observable supraconventional blast and fire effects of nuclear weapons, recognized as the original design goals for these weapons reaching back to the Manhattan Project, were easy enough to grasp, it was Eisenhower’s recognition his reliable, vital intelligence resource, fallout, also served as a veiled, but nonetheless real threat delineating the limits of nuclear power was innovatively new. Ike recognized the fundamentally conservative

---

[828] Hansen, *Swords of Armageddon*, IV-192.
[829] Ibid, IV-195.

approach to strategy the problem of fallout dictated. Rather than embrace LeMay's belief in the harsh virtues of megatonnage or trust to the smaller yields of tactical weapons to overcome the massive fallout effects produced by high-yield weapons , the president concluded nuclear weapons represented an inflexible strategic dead-end whose use was to be avoided.

The great fear of the American government's public engagement with fallout through 1957 continued to be the mantra first elaborated by Dean Acheson in February 1950.

> As the power of mass destruction weapons grows, public opinion will ill support the prospect of war conducted with such agencies and will tend to lose its sense of perspective and entertain wild schemes for the settlement of political conflict.[830]

In this light, the central horror of nuclear war, fallout, came to be seen as a sort of psychic blackmail on government, as if the forthright admission of its existence and risks would sap the will of free people to resist Communist aggression. Acheson's idea did implicitly stand the recently broken American nuclear monopoly on its head by suggesting the extraconventional effects of nuclear weapons would undermine national security just as surely as their supraconventional effects were relied upon to protect and sustain it. Acheson's framing, however, saw fallout as primarily a psycho-social problem amenable to the standard efforts of morale boosting and was the central precept for most fallout policy during the nineteen-fifties.

Over most of a decade that followed, Eisenhower and his advisors continued to struggle with the facts, fruitlessly trying to sever the fallout issue from nuclear weapons. Towards the end of the decade there were mixed signals and clearly a revival of concern underway about the central question GABRIEL asked, but was not given the chance to definitively answer. One report found among documents from 1958 in the AEC's Division of Biology and Medicine, clumsily titled "The Number of Nuclear Weapons Which Might Be Tolerable to World Populations," began by arguing, "It is impossible to state a maximum number of nuclear weapons…to be tolerable to populations of…neutral nations." The maximum yields studied, again updated from the revised 2,000 megaton limit in the later editions of GABRIEL, ranged from 4,000 megatons upward to 1,000,000 megatons! While the supporting calculations were extensive (and somewhat unreadable), the conclusions suggested a bit of a whitewash, considering the yields expended. One table of calculated incidence of injury and death associated with 4,000 megatons of yield foresaw only a rough doubling of the leukemia rate. A discussion

---

[830] Acheson quoted in William F. Vandercook, "Making the Very Best of the Very Worst: The 'Human Effects of Nuclear Weapons' Report of 1956," *International Security*, Vol. 11, No. 1 (Summer 1986), 184.

of risks associated with some significant isotopes briefly acknowledged the potential for infants and children to suffer injury, but then largely dismissed iodine-131 from the discussion because of its short half-life, arguing that removal of the thyroid solved most issues associated with it and hormones were available as replacement therapy.[831] While that might make sense in the calm world of research medical bureaucracy, it would be of doubtful comfort in a post-attack world where people had to grapple with the exigencies of contaminated food and water, let alone enormous demands on specialist medical resources by individuals under wartime conditions.

Another paper, dated 1 May 1959, clearly reflected more up-to-date knowledge and another change in the calculation of nuclear war, a surprising reduction in yield, to just 1,000 megatons – essentially a reversion to a range within GABRIEL's research premise and a far more constrained scenario than contemplated in the intervening years. Titled "Long-Term Biological Effects of a [sic] Nuclear Warfare," this presumed scenario was the result of a limited attack on the United States, perhaps suggesting it might be the estimate of damage from Soviet attacks that evaded NORAD air defenses. While the full implications of iodine-131 were again given limited attention due to its "transient" nature, here the calculations clearly indicated children were likely to receive a dose to the thyroid ten times that of an adult when exposed to the same level of fallout. The report again saw limited long-term consequences, with a disturbingly optimistic caveat attached.

> …[T]he conclusion must be made that the immediate biological damage probably would greatly exceed the long-term hazard.[832]

The president's actions in placing constraints on their testing prompted by fallout demonstrated a similar understanding of the implications of fallout's limits on strategy in the nuclear age.[833] Confirming the immutability of fallout as a strategic factor was the military's

---

[831] "The Number of Nuclear Weapons Which Might Be Tolerable to World Populations," undated, NARA RG 326.73, U.S. Atomic Energy Commission, Division of Biology and Medicine, Project Sunshine, Box 11, 1, 16. The report was filed with other documents from 1958, but could have been composed prior then. It certainly reflected no lessons learned from the 1957 Windscale reactor fire in the United Kingdom.

[832] "Long-Term Biological Effects of a Nuclear Warfare,"1 May 1959, NARA RG 326.73, U.S. Atomic Energy Commission, Division of Biology and Medicine, Project Sunshine, Box 11, 3.

[833] Discussed already, these include Eisenhower's declaration limiting the yield of any single weapon to no more than the yield of CASTLE BRAVO; the close attention paid to at least superficially addressing it as a threat in public; and ready embrace of what turned out to be the dead-end promise of "clean" weapons all suggested Eisenhower took fallout as a serious political problem before data demonstrated it represented an empirical problem. There were secret exceptions to this yield limit in the "dirty" versions of the Mk 17/Mk 24 and the MK 21. The Mk 36 replaced both classes of weapon by 1957, with its "dirty" version yield weighting in at 19 megatons. All such "dirty" weapons were stockpiled in limited quantities and the last, the Mk36 was retired by 1962. Hansen, *Swords of*

rejection of reduced-fallout weapons represented as "clean." Given their deep interest in his many other proposals, the Pentagon was singularly disinterested in the idea of "clean" weapons, even from Teller, a conclusion later confirmed by the results of 1958's HARDTACK test series.[834]

Another factor indicative of fallout's pervasive latent influence was found in the subtext of a 1956 report on the "Human Effects" of nuclear war.[835] Eisenhower took an extraordinarily cautious approach to the panel's primary recommendation – the need to educate the public about the realities of nuclear war in order to address the misperceptions most Americans had about it. Seemingly, a forthright discussion of fallout was also long overdue in order to comply with the president's policy of candor. The Human Effects panel was frank on "the need for constructive leadership" through "the processes of involvement and participation." Given it functioned in a democracy, the panel felt it was necessary to go into detail about the scope of the threat in order to develop enough public support for national security policy to sustain morale in the event of a sudden onset of war. [836]

One excluded topic was fallout, which had to be factored into the findings by the president once the "Human Effects" report arrived at the White House in early 1957. Given the depth of knowledge about fallout Eisenhower clearly possessed, the report's conclusions on the five factors of morale it identified could only engender a heightened sense of alarm once the president brought together its findings about nuclear war with the fallout protection later urged by the forthcoming Gaither report.[837] The "Human Effects" report nonetheless identified factors

---

Armageddon, V-385, V-389, V-396. While not a clear-cut break with its past heritage of megatonnage above all, it was the sort of decided turnaround that indicated the Air Force was beginning to come to terms with the limits that thermonuclear weapons imposed on the rational exercise of war.

834 Hewlett and Holl, *Atoms for Peace and War*, 345; Hansen, *Swords of Armageddon*, IV-190-191. While AEC Chair Strauss trumpeted progress on reducing fallout as "clean," Edward Teller opposed any comment about progress on such technology, fearing it would reveal too much about which designs were "clean," as well as pointing at those that were not. Willard Libby preferred the statement reflect the experience of the entire REDWING series in order to avoid the focus on any one test that made Teller fearful.

835 William F. Vandercook, "Making the Very Best of the Very Worst," 184-195; "Report to the President and the National Security Council by the Panel on the Human Effects of Nuclear Weapons Development," Department of State, S/S–NSC (Miscellaneous) Files: Lot 66 D 95. Top Secret. Another copy of the report is Ibid, PPS Files: Lot 67 D 548, Civil Defense.

836 "Report to the President and the National Security Council by the Panel on the Human Effects of Nuclear Weapons Development," Department of State, S/S–NSC (Miscellaneous) Files: Lot 66 D 95. Top Secret, 15. The panel used this definition of morale: "Morale is the capacity of a group of people to pull together consistently and persistently in pursuit of a common purpose."

837 The Gaither panel will be discussed shortly, but the discussion about fallout that seemed to naturally fit with the Human Effects panel's charge was instead placed with the Gaither Panel's agenda.

that could be usefully applied to a better understanding of fallout's threat. Among these were its ability to undermine "confidence in leaders;" the government's long record of dissimulation on fallout might serve to betray the existing trust needed "for effective communications throughout the group;" and – in the eyes of many already – the government's failure to limit fallout was vulnerable to being seen as trifling with "the health of the group – both physical and mental…an element of major importance."[838]

The Price of Victory

Perhaps without anyone except the president quite realizing it, taken in context the "Human Effects" report ran up against the same problem with fallout that Sean Malloy and others described as originally worrying General Leslie Groves, the head of the Manhattan Project, about TRINITY – at a minimum, concern about the prospect of explaining an apparent technical and policy failure after billions of dollars were spent on it.[839]

For Groves, it was simply a matter of whether or not the device exploded that confirmed the Manhattan Project money was well spent. For Eisenhower, the question was more epistemological. What if every nuclear weapon made did not deliver more real security, but rather undermined it further? The problem of fallout also tended to reinforce Campbell Craig's thesis that Ike was maneuvering to make nuclear war next to impossible except under the direst

---

[838] "Report to the President and the National Security Council by the Panel on the Human Effects of Nuclear Weapons Development," Department of State, S/S–NSC (Miscellaneous) Files: Lot 66 D 95. Top Secret, 15.

[839] Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 1986), 635, 638. Leslie M. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (New York: Da Capo Press, 1962), 360-366. James F. Byrnes, a onetime domestic policy advisor to Roosevelt who was nearly selected instead of Harry Truman as vice president in 1944 was poised to be named Secretary of State after Roosevelt's death in April 1945. A letter from Albert Einstein to Roosevelt on the dangers of using the new weapons was routed to Truman following the death. Einstein's letter drew Leo Szilard, encouraged by Eugene Rabinowitch and others associated with the group of Met Lab scientists in Chicago, to follow-up after Roosevelt's sudden death before the letter could be read and acted upon, by traveling with Harold Urey to South Carolina. Byrnes was living there, still technically a private citizen, but the travelers sought to persuade the new occupant of the White House through him to give due deliberation to the consequences a first use of the atomic bomb would bring. While Byrnes was generally ignorant about the technical details, the discussion demonstrated the scientists were equally ignorant about domestic politics in many ways when it came to the bomb. Byrnes informed them of the fundamental conflict caused by the vast fortune spent on a completely secret project, noting "…we had spent two billion dollars on developing the bomb…How would you get Congress to appropriate money for atomic energy research is you do not show results for the money which has been spent already? Groves was more circumspect in recalling the potential outcome of failure, describing the various means by which funds were hidden with the cooperation of a few select members of Congress and some creative accounting at the War Department with review by the GAO. An auditor sent by the Secretary of War went over things with a fine tooth comb and reported back to the Pentagon that, "If the project succeeds, there won't be any investigation. If it doesn't, they won't investigate anything else." The bomb was paid for, so use was required, it seemed. Groves offered one reason why Truman was chosen over Byrnes as vice-president. Truman was chair of the special Senate committee to investigate national defense spending and had actively helped overlook examination of the Manhattan Project's expenditures.

conditions of national survival.[840] Thus, as Michael S. Sherry explained, Eisenhower faced a rather more systemic problem than the simple failure to successfully detonate Groves feared at TRINITY: What were the political costs of explaining that the Bomb as the central conceptual and material guarantor of national security represented a deeply flawed, perhaps even untenable solution to national security needs – or at least was increasingly recognized as possessing significant limitations?

> Still, atomic peril was also paralyzing…It fostered a fatalistic belief in technological determinism, as if the bomb rather than people determined the world's course, and a deep fear whose focus could be transferred from the bomb to the Soviets, With "fear of the Russians" replacing "fear of the bomb," the "dread destroyer of 1945 had become the shield of the Republic by 1950." Deterrence hardly resolved much, however, especially once the Kremlin acquired nuclear weapons: was it credible to threaten it with nuclear retaliation if the ensuring war might destroy the United States or its allies? Yet if the threat was not credible, what use did America's atomic weapons have…?[841]

How would the public react to news use of thousands of nuclear weapons against the Russians was fundamentally constrained by the threat their fallout posed to American lives?

With the fall 1956 campaign looming, Eisenhower was naturally reluctant to arouse this sleeping dog prior to the election, with the "Human Effects" panel report timed to arrive in December 1956. Work on this national intelligence estimate (NIE) began in March 1956 and was a product of a committee of social scientists, which tended to marginalize the impact of its conclusions from the AEC and the military bureaucracy, casting its recommendations more as a bureaucratic feint, than as an effort intended to fully engage the attention of Eisenhower and his advisers. Its impact and that of the following Gaither Report can be gauged from a general shift to greater openness about fallout beginning in 1957 by the president, the military, in Congress with hearings, and even a greater openness in secret as AFOAT-1 began sharing a basic summary of its secret mission with selected partners elsewhere in government.[842]

[840] Greene, *Eisenhower, Science Advice*, 229-232; Craig, *Destroying the Village*, 68-69.
[841] Michael S. Sherry, *In the Shadow of War: The United States since the 1930s* (New Haven: Yale University Pres, 1995), 134-135.
[842] AFOAT-1, 1956 Unit History, 130-133. In addition to the quickening pace of Soviet tests increasing the need to contact outside organizations and personnel to coordinate establishment of new detachment locations worldwide and the rapid expansion of the use of new techniques that required additional training and equipment acquisition, AFOAT-1 conducted a series of eleven special briefings on its mission and operations. Among those briefed in 1956 were Secretary of Defense Charles Wilson, commanders of various Air Force Commands, Ernest O. Lawrence, and I.I. Rabi.

Craig's description of the "Human Effects" report as pivotal in leading Eisenhower to his conclusion of the necessity of making general war involving nuclear weapons improbable found his argument replicating much of the panel's relegation of fallout to the same small space allowed for fallout to play in the "Human Effects" report itself.[843] This "fallout gap" in the received narrative obscured by dint of its unintended papering over of fallout's supposed inconsequential nature that reflected its intentional historical marginalization because of its use as an intelligence source and its potential "banana peel" effect on American strategic dependence on thermonuclear weapons. The perspective of seeing the problem as primarily a subjective reaction to fallout, rather than as fallout itself being a problem, was cozily and seductively rational. While acknowledging the role of the irrational, it stood in as a substitute explanation for another more substantive motivation for policy change regarding fallout – its empirical effects fundamentally undermined the utility of nuclear weapons.

Because of security restrictions, the issue here, as with much Cold War history, was not inaccuracy so much as incomplete accounting for all significant factors. Thus, Craig's already substantive argument that Eisenhower wanted to make thermonuclear war all but unthinkable, accounting for what he called the "paradox of Eisenhower's military policy," is fundamentally strengthened by reference to the crucial context of fallout and the role nuclear intelligence played in Eisenhower's close and informed command of the levers of national security policymaking. Fallout was often relegated to being an inconvenient or unfortunate and certainly unintended by-product of nuclear weapons despite its clearly consequential, if largely undocumented, role in shaping the presidential anxieties about public "hysteria" and the policy changes needed to address its risks. It was one thing to deal with irrationality when there were few if any facts that supported such conclusions. But if the public's potential for "hysteria" were to be bolstered by available, but top secret-classified empirical evidence, then the issue became quite difficult from a policy stand point.

If the Cold War turned hot, fallout meant that Eisenhower risked the prospect of a sudden defeat in a nuclear war that would be all but literally world-shattering or, alternatively and nearly as grimly, might achieve a victory that would seem much the same as defeat to most Americans. Fallout from thermonuclear weapons made them too dangerous to contemplate using in a

[843] The Human Effects Panel dealt with the civilian side of civil defense policy, yet it specifically excluded the issue of fallout. Instead, fallout protection was assessed by the Gaither Committee, which largely addressed the need to protect SAC's bomber forces, while operating under a greater level of secrecy than the Human Effects Panel.

"preventative" violent overthrow of Communism. This left prevention of war as the only realistic option. Fallout was a major contribution to Eisenhower's grappling with the fact that the paramount national security priority of the Cold War was peace, not the risky potential for war championed in the aggressive posture of containment and confrontation outlined in NSC 68.[844] Notably, despite a number of references to it and a chapter titled "Fallout" and as with Richard Rhodes, Craig's monograph on nuclear strategy did not index the term, reflecting his concentration on the familiar historiographic interplay between social actors as the notable narrative factors. Given General Gavin's revelations in May 1956, Eisenhower already knew that the fallout from even a putative military victory would kill the "hundreds of millions" Gavin described to Congress.[845]

If nuclear hostilities broke out, what "victory" might be snatched from the jaws of defeat depended on quick and decisive action in order to conclusively limit the Russian side's ability to make war; only massive retaliation could do that, but as few but the president understood, only at the cost of exposing one's own nation and the rest of the planet to fallout on a scale almost beyond human understanding in its scope and threat to humanity, even if the Soviet Union were caught so flat-footed as to be unable to get off a single retaliatory shot.[846] Craig's portrait of Eisenhower noted his original, if somewhat conflicted view on deterrence put him in much the same corner as LeMay – favoring the threat of a decisive retaliatory strike to discourage Soviet aggression. Yet the president clearly and consistently remained at odds with LeMay in his stated aversion to the SAC commander's insatiable appetite for high-yield weapons, even as the Air Force continued to embrace them as an effective solution to the Cold War confrontation.

The president's rationale for grudgingly embracing massive retaliation was simple and, as Craig noted, seemed to parallel LeMay's.

---

[844] Craig, *Destroying the Village*, 56. NSC 68's confrontational posture of containment as a prelude to a roll-back Soviet power implied eventual war between the superpowers. The threat of fallout clearly limited the credibility of such a policy. Returning for his first NSC meeting on 12 January 1956 since suffering a heart attack, Eisenhower wanted to avoid needing the advice of "a lot of long-haired professors," but Eisenhower was determined to "pause and think where we are going in the field of these weapons…no one was going to be the winner in such a nuclear war." At the 7 February 1956 NSC meeting, the president returned to the subject, leaving no mistake on his views, now informed by a growing body of knowledge about fallout, stating the "transcendent consideration – namely, that nobody can win a thermonuclear war."

[845] "Army Fails to Bar Bomb Testimony," *New York Times*, 29 June 1956.

[846] "Massive retaliation" implicitly assumed the United States would be attacked first, yet absorbing a nuclear attack was a poor option if warning of an imminent attack was available, leaving open the question of pre-emptive warfare that early adherents of nuclear warfighting such as LeMay apparently embraced. Neither option, even under the best of circumstances, was likely to leave the United States unscarred.

> [W]hy should we put a single nickel into anything but developing our capacity to diminish the enemy's capacity for nuclear attack…the United States should continue to concentrate on producing a force that is so good and so well distributed that the Soviets will not attack.[847]

Where Ike differed from his erstwhile SAC commander was deterrence. It was a fundamental disagreement, given LeMay's proclivity for bombastic suggestions his crews could quickly resolve any confrontation in favor of the United States. The president's atomic anxieties were arguably aggravated by his visceral response to reading "Human Effects of Nuclear Weapons." The omission of fallout from the agenda of the Human Effects panel was likely an effort to compartmentalize the problem of fallout for security reasons, with the empirical issues of fallout left to 1957's Gaither Report.[848]

From the other direction, Secretary of State John Foster Dulles argued for more flexibility than Eisenhower's plans allowed. Massive retaliation was a difficult diplomatic hard sell for NATO (North Atlantic Treaty Organization) allies, who fretted alternatively between the opposed poles of abandonment anxiety and the fear of becoming a fallout-strewn nuclear battlefield, stuck between the rock of inaction and the hard place of cataclysm. This eventually translated into their acquiescence to a vast expansion of the tactical weapon stockpile available to forward-deployed U.S. forces in Europe as these weapons became operational in the late 1950s. Many of these NATO allies then accepted nuclear warheads under U.S. custodial control to equip their own tactical nuclear forces, primarily air defense and artillery.[849] In Europe, too, the

---

[847] Memorandum of December 20, 1956 NSC discussion, FRUS 19 (1955-57): 380; cited in Craig, *Destroying the Village*, 63.

[848] Snead, *The Gaither Committee*, 2-4. The Gaither committee report made a number of recommendations for force protection and hardening, including construction of a national shelter system. Many of the force protection measures were implemented in whole or in part, but Eisenhower rejected a national shelter plan as too costly.

[849] Craig, *Destroying the Village*, 59-63. The Vista study that figured so prominently at Oppenheimer's 1954 hearing was just the beginning. Between 1957 and 1960, nuclear weapons were provided to NATO allies under U.S. custodial control for tube and missile artillery and the Nike-Hercules surface-to-air missile system, along with aerial bombs and Genie air-to air rockets. NATO members receiving nuclear weapons included Belgium, Canada, West Germany, Greece, Italy, the Netherlands, Turkey, and the United Kingdom. A recapitulation of ground-based weapons by system and country is available at http://www.usarmygermany.com/Units/Ordnance/Org%20Chart_SASCOM%201966.htm. Discussion on the freighted process by which this came about is available as part of a declassified Top Secret study, Office of the Assistant to the Secretary of Defense (Atomic Energy), *History of the Custody and Deployment of Nuclear Weapons, July 1945 through September 1977*, http://nsarchive.gwu.edu/nukevault/ebb442/docs/doc%201A%20custody%20and%20deployment%20history%2078.pdf. Coincidentally, this history also covers the conflict between the AEC and the Pentagon over the wider issues of military custody of nuclear weapons, including another indication of presidential pushback against high yield weapons that appeared more consequential than simply coincidental subsequent to CASTLE BRAVO. Any weapon

serendipitous results of the 1950 GAC's planning for tactical weapons was a grudgingly embraced alternative for NATO military forces that reduced the potential for collateral damage and limiting the fallout high-yield weapons threatened under wartime conditions; there was considerably less enthusiasm for nuclear weapons of any kind among the general population.

When the conversation with the JCS continued the next day, Eisenhower articulated his goal was not defeat of the Soviet Union should it misjudge the situation, but to evaluate whether "the suggested courses of action would markedly reduce the threat of the holocaust described yesterday."[850] In case the point was lost on his subordinates, he emphasized it again in another NSC meeting in January 1957.

> The concept of deterrent power has gone as far as it can. In view of this incredible situation we must have fresh thinking on how to conduct ourselves.[851]

Unlike LeMay and the Air Force, Eisenhower appeared to disabuse himself of any illusion a nuclear war could be "won." It was evident that his faith in deterrence was shaky, too. The president repeatedly demonstrated his concern about the potential cost of nuclear war with the USSR, from the 1953 "cross of iron" speech through to his 1961 farewell address focusing on the threat to democracy posed by the military-industrial complex.[852] Already wary of the supraconventional effects of nuclear weapons, fallout as an extraconventional effect drove the stumbling stone of nuclear weapons' lack of utility beneath his feet repeatedly and unavoidably.[853] It was a message an experienced and wary general was quite unlikely to overlook or ignore.

Another troubling item on the agenda of the 1 August 1957 NSC meeting demonstrated the continuing pressures fallout secretly yet effectively placed on the president and his advisers. William F. Vandercook examined the context in which the NSC reviewed NIE 100-6-57,

---

of 600 kiloton yield or larger was not subject to the relaxed custody controls Eisenhower authorized the AEC to grant to the military.

[850] Memorandum of December 21, 1956 NSC discussion, FRUS 19 (1955-57): 390; cited in Craig, *Destroying the Village*, 63.

[851] Memorandum of January 17, 1957 NSC discussion, FRUS 19 (1955-57): 409; cited in Craig, *Destroying the Village*, 63.

[852] Craig addresses this at length, but Snead is also generally useful here in painting a far more complex picture of Eisenhower's fraught relationship with nuclear weapons and war plans.

[853] As defined earlier, the supraconventional effects of nuclear weapons are primarily those that differ only in scale from those of conventional weapons, such as blast and fire. Extraconventional effects are those unique to nuclear weapons, primarily the various radiation effects, including fallout, but also the prompt neutron and gamma radiation close to ground zero of a nuclear explosion. Other, more subtle extraconventional effects are also useful for nuclear intelligence, such as EMP.

“Human Effects of Nuclear Weapons Development,” the final report from the panel. Much like Weart’s *Nuclear Fear*, Vandercook problematized fallout anxieties as primarily a subjective human reaction largely disconnected from fallout as a technological problem, similar to Weart’s framing of the issue. The report showed the NSC focused on the belief that fallout’s impact was primarily a political problem amenable to elite control. Many of the issues summarized in the report originated in the harsh, constraining reality fallout imposed on the development of thermonuclear weapons as the inevitable extraconventional augmentation to their enormous potential for supraconventional destructive power.[854]

Paradoxically, even as the Pentagon found new value in Oppenheimer’s legacy of a diverse tactical weapon stockpile by widely adopting the first fruits of the1950 General Advisory Committee’s production plan into frontline service, crudely addressing the issue of fallout by limiting yield, the president’s negative views on the matter of battlefield use of nuclear weapons hardened.[855] Craig argued making nuclear war all but unthinkable except in a clear-cut case of national survival grew into an implicit policy at the root of Eisenhower’s strategic decision-making during his second term.[856] Eisenhower’s views on nuclear war did not so much shift as organically take form from his own military experience, but his alarm over the potential for the escalation of nuclear conflict was reflected in the Human Effects panel’s estimates of stunning devastation in the event of even a relatively limited Soviet attack on the United States.[857] When it was launched in October 1957, Sputnik all but confirmed the Soviet Union was capable of

[854] William F. Vandercook, “Making the Very Best of the Very Worst: The ‘Human Effects of Nuclear Weapons’ Report of 1956,” *International Security*, Vol. 11, No. 1 (Summer 1986), 184-195. NIE 110-6-57 was examined in light of NIE 100-4-57 -- *Implications of Growing Nuclear Capabilities for the Communist Bloc and the Free World*, 9 July 1957. Effectively, the NSC ordered the problem of fallout be examined separately from that which produced it, nuclear weapons. Furthermore, this problem formulation by the NSC elided the reality that, while wartime fallout would certainly be undesirable and more fearsome, the currently anxious public was already motivated by fallout’s impact on them as a wartime effect in peacetime due to the atmospheric testing of nuclear weapons.

[855] These weapons included the M65 280 mm “atomic cannon,” early atomic demolition munitions (ADM or nuclear land mines), and the Corporal and Redstone missiles. All were deployed between 1955 and 1958 to West Germany, with South Korea also hosting the 280 mm cannon and ADM. Info on the M65: http://www.theatomiccannon.com/. For more on the ADM, see: Adam Rawsley and David Brown, “The Littlest Man,” *Foreign Policy*, 30 January 2014, http://foreignpolicy.com/2014/01/30/the-littlest-boy/.

[856] Craig, *Destroying the Village*, ix-xi.

[857] It is presumed that this refers to a close equivalent to the documents referred to in the leaked testimony of General Gavin about the potential impact of fallout on the NATO allies produced by American nuclear attacks on Soviet forces. A 1961 document from the White House Office of Science and Technology offered an outline of a hypothetical Soviet strike on American territory, numbers still largely based on estimates generated by AFTAC, which foresaw a Soviet strike on 213 U.S. targets involving nearly 1,700 megatons. Graphs indicated a limited Soviet strike of about 500 megatons might generate 20% fatalities even with some use of shelters. “Summary of Attack” and “Figure 11, Mixed Attack,” JFK Library, White House Office of Science and Technology OL, Box 23.

launching an attack on the United States with ballistic missiles, while sparking a revival of executive interest in critical scientific advice largely dormant since the 1954 Oppenheimer hearing.[858]

Craig argued that Eisenhower did not have faith in deterrence alone to keep the peace, because deterrence depended on having rational actors on both sides. The consequences of a failure of deterrence with thermonuclear weapons were enormous. One superficially positive aspect of fallout was that it seemed to increase the value of deterrence, even though fallout's contribution to destruction was something SAC specifically rejected as consequential in terms of its targeting protocols. In this sense, General LeMay's vision of deterrence also varied from the president's, as SAC sought to systematically exclude fallout as a consequential factor. This tack was akin to the sleight of mind evident in Radford's proposal to treat defensive tactical nuclear weapons the same as conventional weapons under rules of engagement authority. Suggesting that militarily "clean" weapons were adequate solutions to the problem of wartime cumulative fallout in relation to the arms race was another attempt to create through policy making new classes of nuclear weapons whose use would not be constrained by fear of their fallout.[859] These efforts to "conventionalize" nuclear weapons also reflected the need to limit the influence of outsider beliefs on military personnel, should their potential to create fallout give them pause in employment of nuclear weapons. As Craig argued, the potential for such loose rules of engagement to lead to conflict motivated Eisenhower to deter, not just the Russians, but also the Pentagon from rash action.[860] Selling Americans on such caution was another matter.

---

[858] James R. Killian, Memorandum for President: Science Advisory Committee, Niels Bohr Library, American Institute of Physics; "Memorandum for Mr. Douglas Price: Members and Consultants to the Science Advisory Committee," Niels Bohr Library, American Institute of Physics. Scientific advice was brought back "in house" to the White House after Sputnik by lifting the Scientific Advisory Committee from the Office of Defense Mobilization to be "reconstituted directly in the Office of the President." By 3 December 1957, additional appointments to the committee included I.I. Rabi, who became its chair, Hans Bethe, and one of those targeted in the process of the 1954 Oppenheimer hearing, Jerrold Zacharias. These appointments marked the beginning of the eclipse of the Strauss/Teller dominance of presidential scientific advice that prevailed during Eisenhower's first term and set in motion efforts that produced a far less benign view of fallout than presented previously. After Sputnik, Eisenhower was compelled to treat nuclear war and its fallout as poised the length of a missile flight away, about a half hour.

[859] The definition of a "militarily clean" weapon was defined in a 1959 article on the technology in *Air Force* magazine as any weapon with a design in which 95% or more of the uranium was eliminated from the original design. "The Clean Weapons Problem," *Air Force*, Vol. 42, No. 12 (December 1959), 36-38.

[860] Craig, *Destroying the Village*, 67-70, 77. Campbell Craig called Ike's policy of massive retaliation "all-or-nothing," based on deterring Soviet action by making the results so unthinkable they would find them impossible to consider.

> …even if Eisenhower could abstractly permit himself to believe that general war was no longer acceptable, how could he renounce the idea of American national security during the height of the Cold War? There was no way that he could straightforwardly suggest to his military and civilian advisers, the nation as a whole, and America's allies around the world that the advent of intercontinental thermonuclear weaponry meant that the United States would no longer wage all-out war.[861]

Eisenhower's dilemma on nuclear strategy also explained his reluctance to implement the Gaither Committee's 1957 recommendation for a national fallout shelter plan, while funding its recommendations on force protection, a view that persisted into the Kennedy years, despite Kennedy's vocal support for civil defense. McGeorge Bundy, Kennedy's national security adviser, summed up the situation in 1962, arguing that civil defense was "a losing battle," regardless of Kennedy's own enthusiasm for fallout shelters. Later that year, Harold A. Knapp Jr. argued…

> …deterrence being a psychological phenomenon is enhanced by the more horrible consequences for failing to deter. This bizarre feature of deterrence, with all its unspoken portent for civil defense was first pointed out by Winston Churchill in a 1955 budget debate in the House of Commons.
>
> "After a certain point has been passed, the worse things get, the better. The broad effects of the latest developments is to spread almost indefinitely and to at least a vast extent the area of mortal danger…Then it might well be that we shall, by a process of sublime irony, have reached a stage in this story where safety will be the sturdy child of terror, and survival the twin brother of annihilation."[862]

Eisenhower assessed that the Air Force, despite its massive build-up of more destructive power than expended in all of the wars of history, faced an effective stalemate, even as secret evidence from MUSIC demonstrated a significant American lead in the basic materials of nuclear confrontation.[863] The Air Force was not as sanguine, even as its leadership tacitly and discreetly conceded in quite circular fashion that things had changed because of fallout.

> For the first time in history, no head of state, whether democracy or dictatorship, can promise the man on Main Street clear-cut and certain victory in war.

---

[861] Craig, *Destroying the Village*, x.
[862] Harold A. Knapp, Jr., "Planning for Civil Defense: Five Requirements," *Bulletin of the Atomic Scientists*, Vol. XIX, No. 4 (April 1963), 40.
[863] See Appendix B.

> The most he can promise is devastation of the lands of another people. He cannot promise his people that their own lands will not be blackened.[864]

Like many references to it at the time, General Nathan F. Twining's speech as the Air Force Association's 1955 "Aviation's Man of the Year" did not explicitly acknowledge fallout, but did implicitly warn of the dramatic effects it imposed on strategic policy even as arms control negotiations began at Geneva. Twining was certainly not referencing supraconventional weapon effects that, however powerful, were confined to the general area of ground zero. Rather, Twining was surreptitiously referencing the extraconventional, widespread effects of radiation that traveled beyond the zone of physical destruction to threaten the aggressor's population, too.

1957: The Fragile Nature of Eisenhower's "Clean" Promise

The government's sloth-like effort to rebrand nuclear weapons as "clean" opened it to critical attack as untimely, insufficient, and misrepresented. Commissioner Willard Libby fanned the flames by his clumsy attempts at snuffing out the ill publicity winds carrying fallout. In an AEC press release issued just as the 1957 PLUMBBOB series began, Libby declared virtual certainty the problem of fallout was largely solved.

> [T]he amount of radioactive fallout per megaton of explosive power is very greatly reduced. I believe this is a most important development because it would minimize the potential health hazards to those who are far from the scene of the battle if nuclear weapons are used.[865]

It was a spectacularly ambitious conclusion to draw, given the scope and scale of SAC's war plans, the very limited experimental work completed so far and the daunting challenges further progress on "clean" weapons posed. Commissioner Murray and U.S. Representative Chet Holifield (D- California) of the JCAE both raised objections, arguing Libby's statements were at best misleading. Holifield was blunt about the difference between Libby's statement and the reality of nuclear war.

> It is true that fallout is being reduced. But there is and at present cannot be such a thing as an absolutely clean bomb, i.e., no fallout. Moreover, in any large-scale war, it would seem inevitable that weapons of varying degrees of cleanliness will be used, and the inevitable result will be large-scale fallout.[866]

---

[864] General Nathan F. Twining, "The Shadow of Air Power at Geneva," *Air Force*, V. 38, No. 10 (October 1955) 40-42. Twining spoke as winner of the H.H. Arnold Trophy as the Air Force Association's "Aviation Man of the Year at the organization's annual convention. Reflecting on the initial Geneva negotiations, he argued in support of continued expansion of the Air Force to aid that process, since "airpower is peace power."

[865] Hansen, *Swords of Armageddon*, IV-277.

[866] Ibid, IV-277.

Holifield came close, nudging right up to, but not quite crossing the line to realization it was the cumulative nature of their use in a "large-scale war" that was the problem with fallout, much less so than the individual dirtiness of any specific weapon.

By 5 June 1957, Libby found himself forced to elaborate on his position in a supplement to his earlier statement as his goal became more obvious, declaring, "Unfortunately, there is no substitute for testing…[to develop] designs which would lessen still further radioactive contamination…"[867] Eisenhower, generally reluctant to publicly address the topic himself, surprisingly climbed out on the political limb next to Libby by declaring the U.S. was able to reduce fallout by 90% at one test in a news conference on the same day Libby amended his remarks to the JCAE. Despite some relief found with Commissioner Murray's departure from the AEC at the end of the month, the president confronted the same questions about fallout and the anxieties it engendered twice more during the summer of 1957 at news conferences on June 26 and July 3 as the PLUMBBOB series continued in Nevada.[868] The normally cautious Eisenhower was enticed enough by the possibility to publicly embrace it during the June 1957 press conference, when the president argued the United States could "produce 'an absolutely clean bomb' with 'no fallout to injure any civilians or anyone, any innocent bystanders.'"[869] Each time he offered his personal assurance that the problem of fallout was being addressed successfully, citing discussions with Lawrence and Teller. Interestingly, a significant motivation for Teller's sudden conversion to the need for "clean" weapons was his fear fallout might discourage any use of nuclear weapons, a telling acknowledgement of the growing strength of concern about fallout's capacity to undermine perceptions of their military utility.[870] Teller's anxieties about the impact of fallout were notable for their congruence with the same concerns about hesitancy expressed by Robert Oppenheimer and others in connection with the disputed VISTA report at the 1954 hearing, testimony that remained classified for sixty years.

---

[867] "Supplement to Statement by Dr. Willard Libby, Commissioner, USAEC, Before the Special Subcommittee on Radiation, Joint Committee on Atomic Energy," Eisenhower Library, Anne Whitman File, Admin Box 5.
[868] Hansen, *Swords of Armageddon*, IV-285. Murray's often irritating term as an AEC commissioner ended with the expiration of his term on 30 June 1957.
[869] Ibid, IV-285.
[870] Ibid, IV-283-284. On 24 June 1957, Strauss, Lawrence, Teller, and Mark Mills met with Eisenhower, assuring him that nearly-fallout free weapons were just around the corner, but required further testing to perfect. Eisenhower even explicitly suggested to the group, as General Starbird did implicitly to Strauss, that "clean" design technology be transferred to the Soviets

“Nuclear Bombs Bursting in Air” Overhead – With New Easy-“Clean” Feature

In April 1957, the Army publicly announced its intent to ring American cities with “new missiles equipped with atomic warheads…” in order to defend them against attack by Soviet bombers.[871] Driven by inter-service rivalries, geopolitical certainties, and strategic uncertainties, there was a great deal of competitive rivalry between the Army and the Air Force over how to prioritize responsibility for air defense with the limited funding available for defensive military forces.[872] Fallout’s contentious position complicated the Army’s push for nuclear-armed air defense missiles, putting them in much the same spot as the Air Force, facing the need to convince an American public increasingly uncomfortable with fallout to tolerate it for their own “security.” The Army effectively asked them to accept the possibility of new, nuclear “bombs bursting in air” directly overhead of the most densely populated areas of the nation. Americans were told not to worry, however.

> The general also said the amount of radiation in fallout from an air explosion was “negligible.”[873]

Akin to “nuisance,” “negligible” smacked of sophistry in the context of what the Army, the Department of Defense, and the Atomic Energy Commission knew about fallout at this point. The declaration was clearly a proactive policy pronouncement intended to portray nuclear weapons the way the government wished they were, rather than as it already knew they were. Nuclear air defense represented the leading edge of the Pentagon’s ill-fated effort to conventionalize nuclear weapons, arguing they should be treated as simply more powerful versions of weapons already at the U.S. military’s disposal.

American consumers were reassured in the very same edition of the *New York Times* that if there was fallout, it could be dealt with by such simple methods as “detergent and water.”[874] Newspaper readers in New York and across the country now regularly encountered such efforts

---

871 “U.S. Confirms Atomic Defense Here,” *New York Times*, 23 April 1957.
872 Fred Kaplan, *Wizards of Armageddon* (Stanford: Stanford University Press, 1983), 234.The Army sought anti-ballistic missiles (ABM) to protect cities. The Air Force cited the need to protect its ICBM force in its silos in calling for ABMs to defend its retaliatory force in the Gaither Committee report. Fred Kaplan cited the Navy’s call for the Polaris submarine-launched ballistic missile (SLBM) as a response to the emerging vulnerability of hardened silos as the accuracy of Soviet ICBMs increased. The fundamental problem was bombers were difficult and missiles all but impossible to defend against effectively. This formed the basis of the Air Force’s long-standing position that investment in anything except the deterrence provided by its offensive strategic forces was wasteful. Fallout, as argued in Chapter Three, was a destabilizing threat against deterrence, accounting for the Air Force’s desire to keep its significance marginalized in secrecy.
873 “U.S. Confirms Atomic Defense Here,” *New York Times*, 23 April 1957, 20.
874 “Decontaminants Tried,” *New York Times*, 23 April 1957, 10.

to promote positive spin about fallout in articles, setting the stage for marketing products to relieve fallout worries by playing on these anxieties to increase sales. These clumsy attempts to manipulate public discourse seemed to succeed at first, in the absence of other information. In fact, substantial – and worrying – new scientific concerns, which added context to the popular understanding of fallout, were looming on the horizon, as well as new cultural and social forces generated by fallout overseas that recirculated from the periphery back to the center.[875]

Nuclear Absolutism Leads to Atomic Air Show

The Air Force took its turn to pitch its ability to defend American cities in the May Day 1957 edition of the *Chicago Tribune*. The new weapon was again an argument that the best defense against nuclear weapons was more nuclear weapons. The Commission announced it would open nine shots in the upcoming summer 1957 PLUMBBOB series in Nevada to small groups of journalists, although it chose to omit press observers at the test of a nuclear air-to-air rocket originally anticipated to be on the public test schedule. The reason given for the change was surprisingly frank about why a publicized test was initially considered for a weapon that, if used, would be detonated in full view of millions of Americans.

> A demonstration shot of an atomic rocket was planned to dispel any public apprehension that a high-altitude explosion of such a warhead against an enemy bomber would also rain death upon the city below. [876]

Amid sharp questioning in Congress about the sudden disappearance of the "bomber gap," the Air Force sought to demonstrate its capability to strike down Soviet bombers with the JOHN shot of the 1957 test series. American citizen-consumers were directly asked to adjust their comfort level to accommodate fallout, not in some remote location, but just above the heads of their families. Nuclear defenses in urban skies were safe, because there was "virtually…no danger from these rockets." Not quite safe enough it seemed, because the AEC canceled a scheduled public viewing of this shot due to "the possibility of some extremely slight hazards if

[875] The most poignant case of this recirculation to the center was that of the "Hiroshima maidens," women disfigured by the only two instances when nuclear weapons were used in wartime in 1945. Brought to the United States for reconstructive surgery beginning in 1955 as part of a charitable reconciliation effort, their witness to the horrors of even limited nuclear warfare reinforced the conventional model of nuclear weapons in appearance. Often left untold in the simplification for American consumption were personal stories that frequently included radiation injuries. Championed by Norman Cousins, the narrative of the *hibakusha*, of those exposed to the nuclear bomb, became far more complex than a simple outstretched hand of medical care united with a chance to bear witness to the horrors of war where it served to mark the awful conclusion of the war against Japan. For more on this troubling, transnational narrative, see Naoko Shibusawa, *America's Geisha Ally: Reimagining the Japanese Enemy* (Cambridge: Harvard University Press, 2009), 213-254.

[876] Lloyd Norman, "AEC Drops Test of A-Weapons for U.S. Cities," *Chicago Tribune*, 1 May 1957.

an accident occurs."[877] Instead, the PLUMBBOB JOHN shot was staged and recorded by an official photographer and then publicized as proof of the safety of a nuclear defense.

Conducted at NTS, JOHN attempted to demonstrate the "conventional" nature of Air Force use of nuclear weapons on or above U.S. soil for defensive purposes. A group of five officer/"volunteers" stood at a point thousands of feet directly below the test explosion's Ground Zero. A recording of audio from a film made to record that event provided several insights.

> H-Minus one minute...The airplane is up. Over our shoulders, it is a bright silver spot in the sky…Thirty seconds…John sees it. Twenty-five seconds… Twenty seconds [in background, countdown to rocket firing starts here at 10, 9, 8…] …There it goes. The rocket is gone….We felt a heat pulse, a very bright light, a fireball! It is red; the sky looks black about it. It is boiling above us. It is wrapped in Christ[-BANG!-]mas color! There is the ground wave! It is over, folks. It happened! The mounds[sic] are vibrating! It is tremendous, directly above our heads. We lived! And we lived! [everyone shouting increasingly loudly over the narrator]
> [Second Voice] Boy, I'd hate to have been there!
> [Narrator] There is a huge fireball, the sounds are still echoing through here. Wasn't that a perfect, perfect shot?
> [Second Voice] I think the first time in history that bombers will turn back now.
> [Third Voice] The bombers won't come.
> [Second Voice] I feel this has been a great day for Air Defense Command. There is no question in my mind that that won't do the job that it's designed to do, namely, completely destroy a bomber at that altitude. There is absolutely no danger for the personnel on the ground here. We did feel the heat momentarily, as though one stepped out into the bright sunshine…[878]

For the Air Force's Air Defense Command, nuclear weapons were the obvious answer to the problem of defense against nuclear weapons, essentially a problem that offered its own solution. It was also a solution directly refuting the oft-repeated claim made by airpower advocates that "the bomber always gets through," embracing the same narrative of deterrence it applied to Air Force offensive strategic forces. In the internal logic of the Cold War nuclear absolutism, a nuclear means of defense was the best match against a nuclear threat, simply ignoring fallout was a problem.

The height of PLUMBBOB JOHN's burst (this shot was sometimes referred to as HA, for High Altitude) was reported variously by different sources. Chuck Hansen cited two March

[877] Lloyd Norman, "AEC Drops Test of A-Weapons for U.S. Cities," *Chicago Tribune*, 1 May 1957.
[878] Transcript by author of audio of Genie Test Shot taped by observers underneath conducted by Air Force to demonstrate safety of nuclear combat in American skies. DTRA Audio obtained by Peter Kuran, 25 March 2011, aired during interview with David Inge, *Focus*, WILL AM 580, 28 March 2011.

1955 planning memoranda in calling the shot height as 36,620 feet.[879] The Nuclear Weapons Archive listed a shot height, 18,500 feet, about half that originally planned in 1955.[880] An Armed Forces Special Weapons Project report on radiation exposure to the air crew involved indicated a rocket release and burst height of 19,000 feet, with an accuracy of within ~100 feet.[881] An AEC press release indicated only an altitude of "more than 15,000 feet."[882] Peter Kuran, who produced an audio transcript recorded during JOHN, suggested a much lower shot height of 10,000 feet during an interview.[883] Although his copy of the taped audio was edited, the conversation and spoken time interval heard as the test count-down supports this even lower burst height. The speed of sound requires a count of between 32 seconds (340 meter/second) at sea level and 38 seconds (295 meter/second) at 11,000 meters altitude in order to provide evidence to place the burst height at the test height of 36,000 feet originally planned in 1955. Kuran's audio indicated timing between the flash observed by the participants and the sound of the explosion reaching the ground was considerably shorter, only about twelve seconds, than the interval required to support previously documented burst heights. This indicated a burst height considerably lower, somewhere between 11,614 and 13,385 feet, than previously documented.

The ambiguity about the JOHN shot's burst height associated with this clearly staged performance was indicative of the Air Force's efforts to minimize the issues of utility that fallout increasingly imposed on nuclear weapons. The proposed test burst height suggested to Eisenhower in 1955 was clearly altered to an altitude only half as high – and perhaps even lower, based on propagation of the explosion's sound. The theatrical, staged nature of the JOHN test was obvious in contemporary reporting, which interestingly also pointed toward a lower burst height than originally planned in 1955, as it was said to explode only "three miles up in the sky."

> To demonstrate the safety of the weapon if used defensively over cities, five Air Force officers stood unprotected on the desert directly under today's detonation…radioactive fallout was almost undetectable.[884]

---

[879] Hansen, *U.S. Nuclear Weapons*, 176.
[880] http://nuclearweaponarchive.org/Usa/Tests/Plumbob.html.
[881] "Nuclear Radiation Received by Aircrews Firing the MB-1 Rocket," AFSWP, Sandia Base, New Mexico, 1957, http://www.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet6/brief6/tab_f/br6f1l.txt.
[882] AEC, Press Release, 19 July 1957, http://www.aracnet.com/~histgaz/atomi/john1pr.htm.
[883] Transcript by author of audio of Genie Test Shot taped by observers underneath conducted by Air Force to demonstrate safety of nuclear combat in American skies. DTRA Audio obtained by Peter Kuran, 25 March 2011, aired during interview with David Inge, *Focus*, WILL AM 580, 28 March 2011.
[884] Gladwin Hill, "First Atomic Rocket Fired by Jet Over Nevada Desert," *The New York Times*, 20 July 1957.

Need for “Clean” Weapons Becomes Primary Pretext to Test

The theatrics of the JOHN test came amidst dueling opinions and evidence about the impact of fallout. Having just stepped down as a AEC commissioner in June 1957, Thomas Murray charged that “the public should be informed that nuclear weapons without fallout are not available” in responding to an assertion by Edward Teller and E.O. Lawrence that “smaller hydrogen bombs with essentially no radioactive fallout” were possible.[885] Coming in the early stages of the PLUMBBOB series at NTS, those who formerly only scoffed at the dangers of fallout from testing now embraced the problem as a public justification for further testing to produce the promised advances in “clean” weapons technology. Elite commentators summed up the issue in stark terms.

> No danger from tests of nuclear weapons is remotely comparable with the danger of falling into a second-best position in relation to the Soviet Union in nuclear armaments.[886]

Nuclear absolutism defined the major problems of national security as only solvable through application of nuclear power. This effectively rendered deterrence as a fragile tautology, rather than a reliable theoretical concept. Nothing but nuclear weapons could suffice, although this essentially house-of-cards solution raised as many questions about deterrence and fallout as it settled. The Air Force’s public ambiguity and apparent fudging on releasing information about the burst height of JOHN was indicative of its longstanding efforts to manage public perceptions of the utility of nuclear weapons. The test suggested planned to use of the Genie, the weapon tested at JOHN, against threat aircraft, whether high or low. Like Paul Fackler’s turn of his sampler into the fallout plume at SANDSTONE, pushing the boundaries of flight – and nuclear weapons employment – the lower than originally planned burst height of JOHN fit a long Air Force tradition of pushing exposures to and beyond established limits.

Citizen-consumers were awakened to a closer relationship with fallout when reading about it in the context of the latest tips in household management and interior design. On 9 May 1957, the *Chicago Tribune* carried an Associated Press story with the alarming headline, “Atom

---

[885] “Bombs Without Fallout Held Not Available,” *Los Angeles Times*, 28 June 1957; John W. Finney, “U.S. Eliminates 95% of Fall-out from the H-Bomb,” *The New York Times*, 25 June 1957. While in some cases, PLUMBBOB tests were specifically attributed to fallout reduction efforts, this was a development that followed the general justification for the 1956 REDWING series as a whole. Rising public opposition kept up pressure that drove the AEC to increase its efforts over time to publicly portray them as centered on fallout reduction. Hansen, *U.S. Nuclear Weapons*, 73-74.

[886] William Henry Chamberlin, “Fallout Furor,” *Wall Street Journal*, 26 June 1957.

Fallout Seen as Peril to Thousands." An investigative article in *The Reporter*, described as "a liberal magazine of 'facts and ideas'" founded in 1949, charged that "thousands of persons in Nevada and Utah have been exposed to radioactive fallout from weapon tests." Complaining of "unnecessary secrecy in connection with radiation dangers," the article claimed residents of St. George Utah, in the southwest corner of the state bordering Nevada, "were exposed during on 24 hour period to 1,260 times more than the permissible concentration established for radiation workers." Alarmingly, but quite factually, it stated the AEC "lacked sufficient information to provide proper safeguards for the public or to accurately predict test results." The AEC responded with its now-pro forma denials of hazard "or detectable injury to health."[887]

But it was simply not the case that the government was unable to trace the path of fallout in order to "accurately predict" where it might fall on communities like St. George. Such tracking was standard procedure for fallout moving away from NTS, as the maps of fallout recorded from Air Force samplers tracking the various shots in the 1957 PLUMBBOB test series demonstrated.[888] While neither conducted under AEC control nor completely transparent to the Commission, AFOAT-1's Special Equipment Operators (SEO) regularly gathered samples while flying aboard the planes of its Air Weather Service "contractor" along the flight path on most if not all of these shots as a training opportunity. It was also necessary in order to accurately record the "fallout landscape;" tracking fallout from American tests was an essential part of updating its ever-changing, baseline reference of global fallout.[889]

---

[887] "Atom Fallout Seen as Peril to Thousands," *Chicago Tribune*, 9 May 1957. Hewlett and Holl, *Atoms for Peace and War*, 289-291. While St. George, Utah was within the 200-mile radius where Air Force cloud sampling data was generally provided to the AEC for diagnostic purposes, it remains uncertain whether any of this information was provided on a timely enough basis to serve as warning if and when fallout moved off of NTS. The AEC did not control Air Force sampling. For rad safety purposes, the AEC relied on a network of ground stations operated by the Commission and the United States Public Health Service that the Air Force found were generally impractical for intelligence purposes. The lack of capability to accurately track fallout from NTS was also a result of skepticism about fallout's significance cultivated within the AEC, such as by the director of the Division of Biology and Medicine, John C. Bugher, who argued in 1955, "It is not a question of health or safety in St. George, but a question of public relations."

[888] Miller, *Under the Cloud*, 404-483.

[889] While tracks of fallout from many shots in Nevada, but not all, were declassified, similar data on the higher yield American test shots in the Pacific, as well as those captured as intelligence data on its primary target, the Soviet Union, apparently remain classified and unavailable to researchers over a half-century after it was collected. The Centers for Disease Control and the National Cancer Institute produced a 2001 report, "Feasibility Study of Weapons Test Fallout," to better assess the resulting health impacts of fallout. It was finalized and sent to Congress in 2006. See http://www.cdc.gov/nceh/radiation/fallout/. Unfortunately despite the documented need to better understand the implications of fallout and other low level radiation, the data needed to undertake further research still awaits a decision by the Department of Defense to declassify this data, collected in large part, but not exclusively by AFOAT-1/AFTAC. Readers here should by now understand that this data is among the best

These secret flights also served as rehearsal and training for one of AFOAT-1's wartime missions for the first time in 1956, tracking the fallout plumes of detonations of enemy weapons over U.S. territory. Codenamed BIT BITE, this mission involved SAC, the Air Defense Command, and fourteen state Air National Guard (ANG) units. Sampling at the 1957 PLUMBBOB test series at NTS was the first opportunity for a large exercise involving BIT BITE units. ANG personnel received training from the 4926th Test Squadron (Sampling), which conducted close-in post-shot sampling for the AEC.[890] The otherwise rather pedestrian T-33 jet trainer used by the Air National Guard was recruited for sampling duty. The plane was already in use to collect high-altitude samples for AFOAT-1 from Soviet tests as they drifted over Japan.[891] These specially-configured ANG aircraft, two each to fourteen different units for twenty-eight total, supplemented AFOAT-1 sampling capability over the continental United States in the event of war to provide forecasting data to the Weather Bureau and Civil Defense. Getting a handle on that data for both short-term and long-term planning and coordination was now a vital aspect of warfighting and civil defense.

While long-range sampling of U.S. tests by AFOAT-1 occurred throughout the era of U.S. atmospheric testing, from 1957 on this close documentation of domestic testing fallout apparently became a consistent practice. Scattered references to tracking of Pacific Proving Ground tests suggest similar data was generated for testing conducted there. Then there was the voluminous collection data generated on the primary targets of the AEDS, Russian and other foreign nuclear tests. The program generated an enormous quantity of data on the dispersal of fallout across the United States and beyond, but much of this data trove remains just out of the reach of investigators, as it has for more than a half-century.[892] That this data continues to represent a risk to national security becomes more palpably risible with each passing year.

documented and most reliable available, simply because of its original status as intelligence data. Within the report, "Appendix D: Document Preservation and Retrieval, Current and Potential New Activities," discussed the circumstances that apply. "If there is ever going to be a study of the health effects of all nuclear weapons tests using original data, the information collection phase must be done soon." http://www.cdc.gov/nceh/radiation/fallout/feasibilitystudy/appendices_vol_2_appendix_d.pdf, D-1. And there the report sits in 2016, awaiting action that may never come from Congress.

[890] AFOAT-1, 1956 Unit History, 122-123.

[891] AFOAT-1, 1957 Unit History, 26-27.

[892] Data from continental testing at NTS by the United States has been released, but the bulk of this data store remains classified.

Paper Chase – Pursuing the Illusory "Conventional" Nuclear Weapon

Thus, conceptual pursuit of a fallout-free nuclear weapon briefly became a central part of the public nuclear weapons narrative, before quickly flaming out. The president's enthusiastic lead was soon followed in Congress, when U.S. Representative Sterling Cole (R-New York) made the argument explicit, while uncomfortably harking back to the military's efforts to conventionalize nuclear weapons.

> The honest objective of this program of experimentation tests and education will be that we have harnessed atomic energy to provide us with just another "conventional" weapon — that is, one which uses blast and heat to destroy the target but with no amount of radiation.[893]

Like President Ronald Reagan's later "Star Wars" ballistic missile defense system, it was a noble idea, but the basis of both notions was more alchemy than science, overlooking the practicality of basic physical laws in the interests of reassuring public relations copy. Belief in a scientific or engineering design deus ex machina to solve the fallout problem put off coming to terms with fallout's natural, fundamental constraints on the use of nuclear weapons, trading the short-term political impact of fostering belief in such a patently impractical scheme into justification for further testing. Given the general lack of evidence of feasible means to overcome the vast technical challenges, what amounted to scientific mythology also found a place at the policy table, seated there by short-term political expediency.[894] For politicians, as for the military, the limitations of the seductive dead end of the "clean" weapon were a siren call, but ultimately only an unworkable fiction.

Interestingly, the shift in Eisenhower's thinking on the matter of fallout that Craig, Greene, and others located as beginning in 1957 took place amid considerable influence wielded by the Air Force on the Gaither committee's agenda, an effort to define the needs of force protection and civil defense. The service saw money invested in civil defense as better applied to its strategic force structure, setting up an obvious tension between these two major aspects of Gaither's charge. Among Gaither's notable members familiar and relevant to this narrative were several who carried the Air Force's water against Robert Oppenheimer, including General James

---

893 Hansen, *Swords of Armageddon*, IV-289. Cole, a former chair of the JAEC, resigned his House seat later in 1957 to become the first director of the International Atomic Energy Agency.

894 The main stumbling block was the need to use a fission device to trigger the thermonuclear stage of the weapon. Teller, Libby, Strauss and others suggested at various times there might be a plausible alternative solution to use of a fission device, but there remains no credible evidence they determined a potential solution that did not require a fission primary.

Doolittle and Ernest Lawrence; balanced against them were others of more independent note such as James Killian, Jerome Wiesner, and I.I. Rabi.[895] As Snead argued, it was "civil defense that had the greatest influence on the establishment of the Gaither committee," yet the bulk of its implemented recommendations eventually focused on improving survivability of U.S. strategic forces. Eisenhower rejected the committee's central civil defense recommendation, a mass fallout shelter program, as financially and politically suspect.

In its comprehensive evaluation of strategic nuclear force capabilities, the Gaither committee worked from estimates of Soviet nuclear delivery capabilities provided by the Air Force. The intelligence community was by then aware that the junior service's historically higher counts of weapons in its analyses were under suspicion of significant inaccuracy because of the controversy over the "bomber gap." The Gaither final report was effectively based on the same worst case scenarios that led to the "gaps" controversies.[896] The Gaither committee also had access to relevant National Intelligence Estimates, including the most recent, which evaluated potential international reaction to an announcement by the United States that it intended to embark on a national fallout shelter program.[897] Crucially, while a few of its members were individually cognizant of it at the time, the Gaither committee as a whole apparently was not briefed on the CIA's U-2 missions over the USSR. Snead argued the U-2 program in 1957 was too young to produce a clear picture of the conflict between the findings in its imagery and the consistently high Air Force estimates of Soviet strength.[898] It was a situation that strongly suggested this proliferation of studies represented a narrowing of Eisenhower's goals in dealing with the problems of nuclear weapons, with avoidance of nuclear war as the highest priority barring compelling, extraordinary reasons to do otherwise. The most important missing piece of the puzzle supplied by fallout was excluded from significant, critical discussion, because the president viewed this highly privileged information as reliable, revealing, and possibly indicative of potential solutions to the problem of inspection, the main stumbling block in any agreement with the Soviets.

---

[895] Snead, *The Gaither Committee*, 49.
[896] Gaither met during the period when it was just becoming clear from the U-2 imagery that Air Force estimates of Soviet strategic forces were far too high. Again, individual members may have acquired some knowledge of this, but it was unlikely that Gaither as a whole was briefed on the need for revisions in the mythology of the "gaps."
[897] This included NIE 100-6-57, "Human Effects of Nuclear Weapons Development."
[898] Snead, *The Gaither Committee*, 102-106.

Thus, Eisenhower's return to discussion of the "Human Effects" report with the NSC on 1 August 1957 presaged the Gaither conclusions, but was also indicative of the president's own emergent clarity on the matter of fallout's effects on policy. After National Security Adviser Robert Cutler reviewed the Human Effects report and noted JCS concurrence with it, the president summed up his view on how much to tell the public about what he concluded about the cataclysmically indecisive nature of thermonuclear war.

> …if we attempted to inform the public on the human effects of nuclear weapons by dramatic actions, we would create hysteria instead of spreading information.[899]

The discussion on this agenda item provided little direct reference to specific effects, but this again seemed as much an artifice to avoid direct reference to fallout's role as an unintended oversight. Given that it was the only direct weapons effect for which there was a recent, significant change in understanding, fallout was the prime suspect as the subject for such bureaucratic obscurantism in the meeting minutes. Fallout was discretely set aside as a topic for the Human Effects panel, apparently because the issue was still highly classified, leaving it to those with the requisite high-level clearances possessed by the members of the Gaither Committee.

In its final report of November 1957, the Gaither committee noted considerable surprise at the previous marginalization of fallout in such policy discussions when it addressed the problem in detail.

> A "fall-out shelter program" may in our final deliberations be recommended as the only feasible protection for millions of people who will be increasingly exposed to the hazards of radiation. Our initial skepticism is yielding to the analysis of the megatonnage which will elude the best defensive systems now predictable."[900]

When 1956 drew to a close, knowledge of fallout's potential effects on policy remained tightly held and largely confined to the most rarefied policy making apparatus serving the president, the JCS, and the AEC, with the latter two uninterested in addressing the issue unless it was forced upon them by circumstances. By the end of 1957, with the Gaither committee's report in hand and Sputnik circling the globe, the situation dramatically changed. It was clear that those with the most expertise on the problems of morale and national political cohesion in

[899] "Discussion at the 333rd Meeting of the National Security Council," Eisenhower Library, Ann Whitman File, National Security Council, Box 9.
[900] Gaither Report cited in Snead, *The Gaither Report*, 120-121.

the face of nuclear war were forced to move on in the relatively short space of a year to include fallout. This shift followed the earlier 1956 shift at AFOAT-1, as it reached out to other units in the intelligence and national security community to better explain its mission.[901]

Isolated in a different compartment from the Human Effects Panel which issued its report in late 1956, apparently in part in order to address the increasingly controversial empirical threat posed by fallout, the Gaither Committee explored the value of shelter during 1957. As the pre-Sputnik era of the Cold War drew to a close, the American military possessed nearly unimaginable, and quite certainly unsurpassed, striking power. A comparison of the viewpoints of two old generals on the best solutions to their fears of surprise attack and the lingering radiation it might bring was a study in contrasts – LeMay, whose fear was deployed strategically in alarming displays intended to justify SAC budgets, and Eisenhower, whose own fears were more private and diverse. For nuclear absolutists like LeMay, the answer to nearly every national security problem was a nuclear weapon. For the latter, every nuclear weapon brought an additional burden. Fallout was now tinged with the sour presidential juices of regret over the very scary corner Ike realized they had all been painted into by the Air Force's hubris over nuclear weapons and the AEC's concessionary treatment of fallout risk. Having publicly opened that bottle with CASTLE BRAVO, there was no putting the bitter wine of cumulative fallout back in. Instead, there was continued silence on that matter, even as policy underwent rapid transformation.

As David L. Snead noted in his discussion of the Gaither Committee's report on civil defense, force protection and strategic force posture, the controversy over fallout was first among several issues the panel was assigned to address in "determining how much destruction the United States and its people can absorb and still survive."[902] Snead observed that "Eisenhower based his decisions on an established set of values and a highly organized decision-making system."[903] This description of the president's general disposition fit well with Eisenhower's long history of innate skepticism about nuclear weapons, intense planning efforts, and his compartmentalization of the various studies of weapons effects and countermeasures reflected in the split of assignments to the Human Effects and Gaither panels.

---

901 AFOAT-1, 1956 Unit History, 130-133.
902 Snead, *The Gaither Committee*, 43-44.
903 Ibid, 7.

The Gaither panel began deliberations in May 1957 and concluded with a classified report issued in early November 1957, just after the uproar over Sputnik struck. For the first time directly addressing the complexities fallout added to civil defense against nuclear attack, the committee's report focused on "a series of questions, the most important being, 'What is the optimum balance between active and passive defense measures for the protection of the civilian population?'"[904] This comprehensive effort to examine the empirical effects of fallout was essentially playing catch-up ball. Having been ignored in the previous year's "Human Effects" report and in other earlier, more thoughtful studies like Project East River, efforts to directly warn the public of fallout's threat seemingly required a high priority, but remained an area approached with trepidation by policy makers, rather than candor.[905]

Significantly, given his role elsewhere in this narrative as a supporter of Oppenheimer, I.I. Rabi was instrumental in determining the scope of the Gaither panel's work.[906] In a letter to Office of Defense Mobilization chief Gordon Gray, who earlier chaired the panel that booted Robert Oppenheimer from the AEC, Rabi set out a broad agenda of research work with its

[904] Snead, *The Gaither Committee*, 46.

[905] Joseph H. McClain, "Project East River: The Strategy of Civil Defense," *Bulletin of the Atomic Scientists*, Vol. 9, No. 7 (September 1963.), 248-252. Project East River was the U.S. government's initial study of the problem of civil defense in the atomic age. Initiated shortly after Joe-1, it was already outmoded by the time its report was delivered, given U.S. and Soviet breakthroughs in thermonuclear weapons in 1952 and 1953.

[906] Snead, *The Gaither Committee*, 46n20. Snead noted a letter from I.I. Rabi to Gordon Gray, Office of Defense Mobilization outlining the specifics needs for an assessment of fallout shelter policy appeared to be the framework for the Gaither Committee's approach to the question. Greene, *Eisenhower, Science Advice*, 20-21, 58. Eisenhower's appreciation of Rabi's advice was cemented during the president's brief turn as president of Columbia in 1952. Joining with James Killian in 1957, Rabi convinced Eisenhower to broaden the range of scientific advice he received, which was the beginning of the end of Strauss' monopolization of this agenda. Greene argued that the eight years prior to his election served as Ike's "atomic age apprenticeship," with his post-election briefing on the successful IVY MIKE test just days before serving as the final exam that eventually drew him to the conclusion that, while atomic war seemed winnable, thermonuclear war was simply inconceivable. Greene cites Hewlett and Holl, *Atoms for Peace and War*, 1-16 on this, which substantially covered the impact of the weapon on strategy, but was effectively in the dark about Eisenhower's relationship to nuclear intelligence and fallout. Ike was not exactly as rudderless on these matters as it sometimes seemed in both Greene's and Craig's portrayals. If anything, Eisenhower's capacity to transform lemons into lemonade, converting purely intelligence functions of the military under AFOAT-1into a functional support mechanism of verification in support of international policy, was part of the presidential coping mechanism. Like Craig, Greene did a service of incalculable worth to the subject matter at the same time he did not notice some things of great importance in fleshing out a holistic history of the Cold War, topic areas that fell through the cracks because of the limitations of the material's security classification. This was most apparent in his discussion of an interchange Oppenheimer reported in 1955 with a member of the French U.N. delegation, M. Jacques Tiné, over prospects for a test ban and methods to enforce the ban. Oppenheimer supported a ban, but "informed Tiné the methods and analysis of this evidence were so secret that the United States would not agree to share its techniques with an international body." Greene also remarked that Oppenheimer was "unconvinced that testing posed significant health hazards…" Oppenheimer was certainly worried about the cumulative effects of wartime use. Certainly, his own recent experience left him with the opposite conclusion about the U.S. government's reason for its lack of enthusiasm over sharing verification technology – it would reveal as much about American fallout as anyone else's.

particulars shaped in significant part by the need to address the issue of fallout in various ways, ranging from "the deterrent value of shelters" to a broadly constituted evaluation of various near- and long-term ways to build shelter capacity.[907] Rabi's research and development agenda was a breakthrough, at least in secret, finally putting fallout formally back on the table as a factor in national security policy for other than intelligence purposes for the first time since Oppenheimer's involuntary departure. Rabi's memo likely was the proximate initiative behind much of the subsequent fallout research in the late 1950s.

Benjamin Greene noted the Gaither report addressed most of Rabi's lengthy list of needs to better define fallout risk and protection.[908] By establishing the problem of fallout as a crucial area of civil defense for the Gaither committee to address, Rabi constructed a critical counterbalance at the opposite policy pole from the Strauss/Lawrence/Teller axis, demonstrating the rebirth and ascendancy of scientific anxiety over fallout underway among the government's own advisers. Oppenheimer was physically purged, in part to limit the potential for his crisis of enthusiasm over nuclear weapons spreading elsewhere inside the government. However, the president's evolving state of mind on the problem of nuclear war was highly indicative of the persistence of the concerns Oppenheimer had earlier raised about fallout. The subsequent dismissal by Eisenhower of Gaither's call for a massive national shelter network to meet the challenge of fallout strengthened Craig's argument that the president's goal was prevention, not preparation for war.[909] If deterrence supported by nuclear weapons failed, shelter could not ameliorate the long term consequences of fallout after the first few iterations of nuclear assault.

As fallout became a regular item on the NSC's policy agenda in 1957, it was self-evident, if still a closely held secret, that growing recognition of its extraconventional empirical impacts

---

[907] Snead, *The Gaither Committee*, 46n20.
[908] Ibid.
[909] Craig, *Destroying the Village*, ix, 73. Craig suggested Eisenhower shifted to prevention in 1955 and 1956 only after the outcome of CASTLE BRAVO made it clear fallout would severely constrain use of thermonuclear weapons. However, as discussion of Eisenhower's earlier interactions with Oppenheimer in Chapter Three suggested, these misgivings dated back to at least their 1951 meetings to finalize the findings of the VISTA report. Craig argued the Gaither report represented "a comprehensive criticism of Eisenhower's nuclear policies…" Certainly, the buck stops at the president's desk when it comes to responsibility for decisions on national security strategy. However, given the machinations of the Air Force in bringing down Oppenheimer, the service's efforts resulted in just one politically viable choice early in his first term, massive retaliation. It was this manipulation of the policy and planning process that Eisenhower later invoked as the threat posed by the military-industrial complex, given presidential policy making is so often dependent on the quality and veracity of the advice received. Eisenhower's careful apportionment of the division of labor on the general problem of nuclear war and the fallout issue between the Human Effects panel and the Gaither committee indicated the president was already uncomfortable with the situation shaped by the fallout problem.

exponentially increased the potential massive social impacts of supraconventional weapon effects. Fallout made possible a situation in nuclear war so untenable it need not be analyzed in detail, considering the other effects already predicted to create a socially- and environmentally-toxic post-attack environment.[910] Recognition fallout made thermonuclear war unwinnable also ironically reinforced the argument it was best to invest in deterrent forces.

Arguably, Eisenhower's eventual formal rejection of the shelter construction proposal found in the 1957 Gaither report reflected the emergence of the president's belief that there was no effective solution, shelter or otherwise, to the problems of thermonuclear war. From this perspective, factoring in fallout was a substantial contribution that could strengthen Craig's general argument. Eisenhower chose to pursue the idea of shelter with Gaither only to use the resulting recommendations as a counterbalance to undermine the Air Force's continuing rush towards nuclear absolutism embodied in the bulk of the Gaither report's recommendations, which focused on increasing the survivability of U.S. strategic nuclear forces. Choosing to refrain from commencing a massive shelter program became a sort of poison pill in Eisenhower's national security policy, recognition that leaving all at risk nurtured a greater than ever incentive to avoid nuclear war. Intended to aid in emphasizing stalemate in the face-off with the Russians, Craig argued Eisenhower also intended to restrict the Pentagon to a limited range of options that all but precluded use of nuclear weapons, with the sole obvious exception being as a reaction to or preemption of a mass Soviet attack, the fabled "nuclear Pearl Harbor."[911]

Eisenhower's approach to managing these advisory panels was typical of what Snead identified as a more general feature of Eisenhower's management of national security policy.

> [Eisenhower] had attained his objective of avoiding war with the Soviet Union by engaging in a form of personal administration…Only he knew what he was doing, what his real purpose was – no one could fill it in for him. Officially, both the writing of nuclear policy and decisionmaking during the 1958-1959 Berlin Crisis incorporated the efforts of dozens of American planners, negotiators, and soldiers. Effectively, both endeavors were undertaken by the president himself, with aides from Dulles on down simply accomplices.[912]

[910] General Gavin's leaked congressional testimony that hundreds of millions would die from fallout effects mentioned earlier on pages 307-308 seemed confined to an evaluation of the toll in Europe. However, the winds blow east so that global circulation patterns would spread the effects of those weapons expended by both sides of a nuclear war throughout the Northern hemisphere.
[911] Craig, *Destroying the Village*, 68.
[912] Snead, *The Gaither Report*, 117.

However, without a forceful partner – fallout – it is questionable that even Eisenhower's leadership and restraint would have been effective in constraining those seeking aggressive confrontation with the USSR.

Going Underground: Anticipating the End of Fallout? Or Just the End?

Cultural, diplomatic, and political pressures aside, AFOAT-1 anticipated wider recognition of fallout's risk could diminish its role as an intelligence source with significant restrictions or even a ban on testing in the atmosphere. Some in the Air Force also continued to hold the long-running suspicion the Russians were successfully concealing other testing the unit was unable to detect. While largely politically motivated, this belief suggested pressure to commit additional effort to develop techniques to detect nuclear explosions by means other than direct sampling of fallout. New or expanded capabilities were required if AFOAT-1 was to continue providing even a much-reduced portion of the useful intelligence on Soviet weapons design which sampling and analysis of fallout produced. AFOAT-1 responded to these possibilities by emphasizing development of alternative long range detection technologies, particularly those that provided some level of near-instantaneous alerting. Improvements in seismic and EMP detection capabilities received specific emphasis during the late nineteen-fifties.

For the Joint Chiefs of Staff, with their access to the Soviet weapons program provided by AFOAT-1 and through understanding the AEC weapons development and stockpile situation via the Military Liaison Committee (MLC), including the American fallout contribution, the math was stark and simple, the big picture clear. Because of fallout they would produce, under a policy of massive retaliation the enormous destructive capability of SAC's nuclear weapons threatened the future of the United States almost as surely as it held Soviet society at risk, regardless of any destruction the Russians might cause on their own. It was problem formulation Libby, Strauss, Teller, and a few others, such as Oppenheimer and LeMay, certainly understood viscerally. By 1956, whatever level of fallout the cumulative yield of a general nuclear war might generate would be more than enough to enter well into the territory GABRIEL warned was dangerous, even with a revised limit of 2,000 megatons.[913] American strategy thus

[913] Massive retaliation as formal American strategy passed away relatively quickly and was typically considered to have formally come and gone as policy entirely within Eisenhower's presidency following its adoption of the first SIOP in 1960. In large part, this was due to the tailwind fallout precipitated against it, driving it offstage, but never really out of influence, given it would be hard to parse the likely results of the SIOP from what would have taken

increasingly embraced the mysterious panacea of deterrence in growing recognition of the need to prevent nuclear war, rather than simply prepare to wage it. To acknowledge fallout deterred the Soviets from war seemed simple enough, but as with the naïve belief that the United States should play up Russian fallout as a threat, the trick in making such a justification was to avoid explaining how fallout just as effectively deterred American decisions about war, too.

In the short term, anticipation of a requirement to place U.S. test shots underground merged with AFOAT-1's need to better characterize signals from potential clandestine Soviet underground tests. The 1957 RAINIER test (1.7 kilotons, 19 September 1957) was the first full-fledged U.S. underground shot, as well as the first underground nuclear test anywhere with a goal of fallout containment.[914]

While concerns raised at SAC over its continuing unmet priority for high-yield weapons lingered, the Pentagon moved enthusiastically forward with multiple new requirements to further diversify the range of available medium yield strategic and lower yield tactical weapon designs. UCRL continued producing tactical weapon designs, after coming into existence in part because Los Alamos was supposedly concentrating too much effort on these very weapons under Oppenheimer's influence.[915] This line of march was a familiar, if long elided one that conceptually brought to fruition the well-laid plans of the 1950 Oppenheimer-chaired GAC.

SAC, Post-Oppenheimer

While Robert Oppenheimer clearly lost his battle, his opponent in the conflict over the heedless treatment of fallout in the Strategic Air Command's war plans, SAC commander General Curtis LeMay, appeared to gain the Air Force he and his fellow generals sought – with freedom to disregard inconvenient facts in the face of public opposition. Over the course of nearly a decade under his command, LeMay built an impressive fleet of thousands of intercontinental jet bombers provided with an arsenal of thermonuclear weapons, controlled as a

---

place under the massive retaliation strategy. While no longer a formal part of the methodology of strategic planning, the sheer numbers of anticipated weapon deliveries in effect under scenarios of general war suggest there remain several levels of massive retaliation still in effect, regardless of the terminology used to describe current policy and planning. The significance of the looming presence of thousands of warheads available to strike hundreds of hardened targets remains the massive fallout such an attack would generate. While a successful first strike might largely confine physical destruction to the targeted nation, the resulting fallout would present a global catastrophe about which little could be done except to endure. Nuclear winter is another effect sometimes anticipated to occur.

[914] The 1951 BUSTER-JANGLE series included a rather dirty shallow, sub-surface shot, but RAINIER was the first attempt to contain such an explosion underground. The first Soviet underground shot did not occur until 11 October 1961.

[915] Hansen, *Swords of Armageddon*, IV-125-127.

global strike force.[916] By 1956, confidence in SAC's ability to deter Soviet attack was high, even as an urgent need remained: accurate identification of actual targets for its bombs. Planning for use of lower yield weapons required increased accuracy in targeting and increased confidence that air crews could reliably hit their marks.

LeMay ordered a mass overflight, Project HOMERUN, going far beyond the typical Peacetime Airborne Reconnaissance Program (PARPRO) flights frequently conducted adjacent to Soviet airspace.[917] Taking off from remote Thule Air Force Base, Greenland, hundreds of miles north of the Arctic Circle, in early May 1956 a gaggle of six RB-47Es penetrated the remote north shore of eastern Siberia. After flying hundreds of miles directly south at 40,000 feet deep into Russian air space, they turned east, emerging into international airspace again roughly 1,000 miles later over the Bering Sea to recover at Eielson Air Force Base, Alaska Territory. There, they rested and refueled before returning to Thule. While the lack of Soviet reaction suggested complacency, in reality the area was lightly defended. A total of 156 missions flown saw less than a handful of unsuccessful attempts to intercept.[918] With the immediate goal of the project to locate suitable targets for some of the thousands of nuclear weapons now at SAC's disposal, LeMay may have been less pleased than such an account of tweaking the Russian's nose would otherwise indicate. A largely empty land also meant it was largely empty of targets. This remoteness may have been part of the reason the Russians did not treat the flights, grouped together on radar, as the first waves of a preemptive American attack – and react accordingly. They would soon have other, more challenging opportunities.

The first CIA U-2 overflight of Soviet territory took place shortly after on 4 July 1956. The plane and its special cameras were the leading wave of a second generation of imagery collection systems designed to extract a diverse variety of data from imagery, a sharp contrast

---

[916] Kurt Wayne Schake, *Strategic Frontier: American Bomber Command Bases Overseas, 1950-1960* (Trondheim: Historik Institut Det Historisk-Filosofiske Fakultet NTNU, 1998). The troubled B-36 was the first truly transcontinental bomber, forming the bulk of SAC's long-range forces by 1950. Its size, slow speed, and general World War Two-technical vulnerabilities caused SAC to turn to the B-47 jet bomber. Produced by the thousands, the B-47 filled the gap until the B-52 arrived in large numbers starting halfway through the decade. The B-47 was comparatively short ranged, leading General LeMay to invest in ringing the Soviet Union with forward bases to house these bombers and their tankers a short flight away from their targets.

[917] By accident or under orders, PARPRO flights were in involved in the majority of Soviet shoot-downs of U.S. aircraft during the Cold War justified by claims by the Russians they violated its airspace. When the United States did acknowledge such losses, it typically claimed navigation errors were responsible or that the Russians acted in international airspace instead of their own.

[918] Curtis Peebles, *Shadow Flights: America's Secret Air War Against the Soviet Union* (Novato, CA: Presidio Press, 2000), 123-128.

with the first generation American intelligence systems designed to extract specific information with a narrow "field of vision" focused on a specific target, with the preeminent example being the AEDS. The result would be a more accurately nuanced view of the threat posed by the Soviet Union's strategic nuclear forces that provided the breathing room for policy makers to pursue effective diplomacy, rather than preparing only for a war that all would stand to lose.

1957: Downsizing Destruction

In secret, fallout shared credit with better understood features such as rapid advances in weapon design efficiency, incorporation of solid state devices, and increasing missile system guidance accuracy in shaping the emergent empirical realities of nuclear war. By 1957 a combination of those factors began to reshape strategic policy largely based on the publicly stated preferences of air power boosters for high-yield weapons. The net result was increased delivery system accuracy that reduced the yield requirements for optimal destruction of a target.[919] Dwight Eisenhower's personal preference to limit the size of the largest American nuclear weapons was another significant, if largely secret and somewhat compromised reaction. The quick retirement of the several models of high yield emergency capability weapons, hastily stockpiled in 1954 even before their designs were standardized, was followed by the nearly equally speedy retirement of the 15 to 20 megaton MK 17 carried by the giant B-36 bomber. The last of these weapons left the U.S. stockpile by August 1957.[920]

Despite the informal presidential limit on the maximum yield of individual weapons, the total megatonnage of the U.S. stockpile continued its rapid growth, reemphasizing the geometrically larger scale cumulative wartime threat fallout posed than by fallout created through testing. Between 1956 and 1958, the inventory of U.S. nuclear warheads more than doubled, rising from 4,618 to 9,822.[921] Thus, a primary feature of the Pentagon's first phase of its policy shift in response to the problem of fallout was a half-hearted, technical observance of

---

[919] The point here is not that improvements in stockpile mix and weapons capabilities quickly resulted in a safer world. The first SIOP was still several years away and the Cuban Missile Crisis still further into the future – and the world is only somewhat safer than at the end of the Cold War. However, the material basis for more rational, if still highly problematic war plans was available in short order after high-yield weapons proved beyond troublesome.

[920] Hansen, *U.S. Nuclear Weapons*, 106, 145-148. The Air Force clung initially to the idea of improvements in manned bombers, operationally fielding the supersonic B-58 Hustler and experimenting with the faster, higher B-70. The same improvement in surface-to-air missile technology that came about with the Soviet development of the SA-2, bringing down Francis Gary Powers' U-2 in 1960, made such high-altitude, high-performance tactics obsolete. In the meantime, inter-continental ballistic missile technology quickly eclipsed aircraft with both speed and accuracy.

[921] See Appendix B; http://www.nrdc.org/nuclear/nudb/datab9.asp.

presidential limits on the maximum yield of individual weapons even as it continued to acquire quantities of nuclear weapons far in excess of any reasonable prospects of practical use.

Placing limits on total megatonnage likely to be expended by the United States was in line with the findings of studies like GABRIEL and Project Sunshine, but it was a solution fundamentally incompatible with SAC's war plans under LeMay's leadership as his time there drew to an end. SAC's war plans depended on rapid execution through delivery of the maximum bomb tonnage on target in the shortest possible time. The cumulative risks posed by fallout inherent to SAC's strategy represented the most significant threat. The problem was not any individual weapon, but detonation of hundreds, if not thousands in a short period of time, which represented the grave hazard to humanity posed by SAC's chosen strategy.

The Nuclear Air Force Takes Command of the Joint Chiefs of Staff

When General Nathan Twining moved his management team into the Joint Chiefs of Staff chair's office in 1957, it was as someone intimately familiar with the benefits of AFOAT-1's work. The direct reporting role of AFOAT-1 under the direction of the JCS continued, so for the first time the Air Force unit's efforts were expressly directed by an Air Force officer.

Twining was intimately conscious of the relationship between nuclear intelligence and the creation of the powerful Air Force prior to his promotion to Chair of the JCS. Twining understood how much the Air Force institutionally benefited from the intelligence data the secret unit generated about Soviet nuclear strength. Twining commanded the 20th Air Force when its base on Tinian served as the launch pad for the atomic strikes on Japan. Then Twining served after the war as chief of the Air Material Command when the long-range detection mission was shepherded into existence under General LeMay's oversight there with Bim Wilson's assistance. At the same time, the AMC was preparing to use the upcoming 1948 SANDSTONE series as an open-air research and development laboratory for further refinement of LRD techniques.

General Twining then took what some likely considered a rather odd assignment to the backwater Alaskan Command. Rather than being a lull in an otherwise up and coming officer's career, the assignment placed Twining in the ideal position to manage implementation of the new long-range detection techniques AFOAT-1 deployed in collaboration with the Air Weather Service. Flying from Alaskan bases anchoring the northern ends of the Air Weather Service's synoptic tracks to Japan and back, the sampler-equipped long-range aircraft operated back-and forth where the prevailing winds were most likely to carry fallout out of the Soviet Union.[922] Like his subordinate LeMay, it was unlikely mere coincidence placed Twining squarely at the center of the Air Force's developing rationale for its vast Cold War nuclear build-up.

Twining and his cohort's professional competence also made them keenly aware of the problems fallout increasingly posed to the construction and implementation of national security policy. Loss of fallout's secrecy was of relatively small import, given prior Russian knowledge of the value Americans placed on fallout, but it paled in comparison to how the loss of the Air Force monopoly on information about it directly and increasingly constrained the Air Force's own prerogatives in choosing weapons and tactics. In the face of a threat described largely through fallout and krypton-85 analysis, the Air Force knew better than anyone how central it was to their argument for the postwar shift of budgetary resources to the Air Force that served as the foundation for SAC's spectacular expansion. Stunted at first by limited funding under the parsimonious Truman administration, the SAC build-up quickly accelerated after the detection of Joe-1 in 1949 closed out four years of lean postwar budgets. Fallout was both evidence of and motivation for the Air Force's organizational success. Its lack was closely associated with memories of lean times for the Air Force leadership, much as most Americans remembered the Great Depression with a similar lack of nostalgia, even as they took pains to invoke its memory as evidence of personal fortitude.

By 1957, General LeMay built the Strategic Air Command from a hollow, postwar shell into a fearsome nuclear striking force that was still expanding its capabilities. In concert with Twining's promotion to JCS Chair, LeMay was promoted to Air Force Vice-Chief of Staff as the service's leaders shuffled command positions. LeMay and many other officers in Twining's cohort were intimately familiar with the context, priorities, and significance associated with AFOAT-1 in building a technologically superior Air Force capable of visiting vast destruction on

---

[922] General Nathan Twining, biographical sketch, http://www.af.mil/information/bios/bio.asp?bioID=7436. J. Britt McCarley's dissertation, "General Nathan Farragut Twining: The Making of a Disciple of American Strategic Air Power, 1897-1953" (Philadelphia, Pa.: Temple University, 1989) seems to be the only extensive biographical work on Twining's career and ends in 1952. An anonymous Air University critic argued McCarley's dissertation provided "little insight into Twining's personality, leadership, reasons for success, or his impact on the great events happening around him." http://www.airpower.maxwell.af.mil/airchronicles/cc/twin.html,This author has not read McCarley's work, but the Air University critique is poignant, given the secrecy, selective declassification, and lack of access for researchers to key information that continues shroud much of the Air Force's Cold War history was as likely a culprit as any perceived failings by McCarley. In this work, Twining's role is more obvious and logical, even without the capability to immediately pursue in detail an intriguing line of research about Twining's career provided by better knowledge of the important role of fallout in Air Force operations.

America's enemies. But it was also a group whose strategies were threatened by bumping up against a growing body of empirical evidence of the peril from what they had long dismissed as an arbitrary nuclear ceiling imposed by fallout. An extensive literature exists on the dominance of SAC wagging the Air Force dog in relation to other factors such as the problems of warning, overkill, war fighting, and survivability in the midst of mutual destruction from thermonuclear war potentially so vast it would threaten the survival of humankind.[923] With a similarly fundamental role, fallout played a vital role in growth and sustainment of the newly independent Air Force. A decade later, countervailing forces were at work.

Just when the Air Force appeared to be in position to cement its ascendancy as the dominant strategic force, Eisenhower's cautious and conflicted process of developing a viable nuclear strategy led to an attack on the Air Force from a vulnerable quarter, its partners in the Department of Defense, the Army and Navy. Eisenhower's frustration with the lack of clear-cut options to general nuclear war led to a request for their evaluation of the Air Force's war plans, with a specific focus on the issue of high yield weapons requirements. The results of the study, Project BUDAPEST, were alarming, with the number of potential targets growing in the course of the study from 2,997 to 3,261 as it was drafted in 1957. Lori Lyn Bogle, a historian at the U.S. Naval Academy, summed up the situation succinctly.

> [F]ar more weapons were being assigned to targets than were needed to achieve the damage required…the resulting radiation and fallout would be dangerously and unnecessarily high. Blast radii were huge, and there were as many as seventeen overlaps on a single location. Additional and duplicate weapons were assigned in profusion, even when the supplemental damage they would achieve was minimal.[924]

Behind the closed doors of the Joint Chiefs of Staff, by mid-1957 the Army and Navy arrived at virtually the same conclusion about SAC's plans as Robert Oppenheimer did in 1951. It was the same concern GABRIEL expressed nearly a decade earlier. The cumulative fallout from a general nuclear war would quickly afflict the victors, as well as the defeated. In essence,

---

[923] Schake, *Strategic Frontier*. Schake's work on the 1950s expansion of SAC's ring of bases surrounding the Soviet Union was not a critique, but offers considerable insight into the practical difficulties of planning for nuclear war; Michael S. Sherry, *In the Shadow of War: The United States since the 1930s* (New Haven: Yale University Press, 1995). Sherry provides a thorough critique of the postwar Air Force, weighted against the predominant world view that sustained such costly efforts; Barry H. Steiner, *Bernard Brodie and the Foundations of American Nuclear Strategy* (Lawrence: University Press of Kansas, 1991). Steiner examined Brodie's seminal work in terms of the sophisticated rationales developed for poising the world on the cliff of nuclear war.
[924] Lori Lyn Bogle, *The Cold War: National Security Policy Planning from Truman to Reagan and from Stalin to Gorbachev* (New York: Taylor & Francis, 2001), 89-92.

inside the Pentagon by 1957 the execution of SAC's war plans was recognized as impractical, regardless of its morality.

Fallout in the Consumer Society: No Shelter for the Mind – or the Budget

Paradoxically, fallout became less of an intruding, concrete contingency in daily life as pragmatists grudgingly accepted it as an inevitability associated with nuclear weapons. Consider the distraction from thinking more broadly about the implications of fallout supplied by the mere discussion of fallout shelters. Marketing shelter turned the narrative toward a more comfortably narrow one of consumption. Once reduced to a consumer product, the enthusiasm for the whole discussion trailed off around America's dinner tables during the nineteen-fifties. Even though the first "model" shelters went on display in 1955 in the wake of the CASTLE BRAVO report, sales were abysmal.[925]

Laura McEnaney argued the inactive, passive nature of concept of shelter, and civil defense as a whole, acquired a gendered character as "feminine" prior to World War Two, a social norm of patriarchal society that persisted into the nuclear age. A 1960 survey commissioned by the House Military Operations Subcommittee found only 1,565 home shelters in the United States.[926] The political preference for the active, masculine nature of military force, augmented by nuclear weapons, prevailed in terms of resources committed, publicly or privately, to protection for the population against fallout throughout the Cold War.[927]

Even as Americans were extremely reluctant adopters of the feminized space of the shelter, the threat they faced grew relentlessly. Cumulative U.S./Soviet plutonium stocks stood at

---

[925] "Kidde Kokoon; H-bomb hideaway. Family seated in a Kidde Kokoon, an underground fallout shelter manufactured by Walter Kidde Nuclear Laboratories of Garden City, Long Island." United Press photo, 1955, http://www.shorpy.com/node/15288. Prior to 1955, a very limited interest in home shelter intended to protect against blast or thermal supraconventional effects existed, but was not oriented toward fallout protection. See Michael Amrine, "How to Build a Family Foxhole," *Popular Science Monthly*, Vol. 158, No. 3 (March 1951).

[926] McEnaney, *Civil Defense Begins at Home*, 41, 63-65. The extraordinarily low shelter count reflected two paradigms. First, those few who had shelters were loath to acknowledge that fact, fearing the whole neighborhood might show up in time of need. More significantly, Eisenhower's policy promoted shelter construction as an almost exclusively private choice, where it supplied little more than blueprints and other basic information to the public to advance this policy.

[927] An important distinction not immediately evident was that a fallout shelter was far easier and less expensive to construct than a blast shelter. Fallout shelters only need provide shielding from radiation, while a blast shelter requires additional protection against the extreme overpressures from the direct effects of a nearby detonation and typically would include some protection against fire. Fallout shelter was the low-hanging fruit of civil defense measures designed to address the most minimal needs to protect the population. The only cheaper alternative was "duck and cover" and all other measures were more expensive. For the most part, the purchasing decisions of American consumers joined their political leadership in deciding they could only afford "duck and cover."

11,511 kilograms (9,430/2,081) in 1956, growing to 34,333 kilograms (28,152/6,181) in 1960.[928] Fashioned into more than 20,000 nuclear weapons, the certainty that everyone would lose in such a conflict was not in question, simply the scope of such a tragedy.[929] In the event of survival, how would one reclaim the world in the aftermath of apocalypse? It was easier for most to either ignore such disturbing thoughts or to simply conclude the powerlessness of the situation mandated moving on to purchases of a more practical nature for the growing families of the expanding suburbs, as well as residents from rural and urban areas presumed to be among the first targets of a nuclear war, because their association with or location in proximity to military and other strategic facilities meant even with shelter, their chance of survival was nil.

Marketing and Consumption of Security

While much of the growing policy discussion about the aversive subject of fallout's effects on national security took place in secret among various elites, the conflict was nonetheless reflected in a growing awareness about it as a problem among ordinary American citizen/consumers. For advertisers, whose marketing magic so often depends on the manipulation of consumer anxieties, fallout seemed to offer the prospect of great returns for those with suitable products to exploit the public's insecurities. Attempts to find gold among radioactive debris, which Albert Schweitzer described as "fallen down, is falling down, and will fall down" on everyone, everywhere, began showing up more often in ads in the press.[930]

Among these efforts was a small advertisement promoting the May 1957 issue of *Better Home & Gardens* magazine, one of the postwar arbiters of commonplace suburban consumption. Boasting it would reveal the answer to "The truth about H-bomb fallout danger," the article described findings on the matter by the AEC's Health and Safety Laboratory (HASL).[931] The May fallout article followed a suggestive article, "Leukemia," in the April issue, which discussed its rising rate among adults had many causes. Among them was "'unnecessary' exposure to radioactivity," but cancer was not mentioned specifically connected to fallout by either article. May's HASL feature, "Bomb Dust Radiation," described HASL as a group of "atomic detectives." Director Merrill Eisenbud noted the AEC organization was recently declassified "in

[928] See Appendix B.
[929] "Figure of US and USSR/Russian Nuclear Stockpile, 1945-2002," http://www.nrdc.org/nuclear/nudb/dafig11.asp.
[930] "The World: Debate on Fallout," *New York Times*, 28 April 1957.
[931] Identical advertisements appeared in both the *Chicago Tribune* and the *Los Angeles Times* on 29 and 30 April 1957 respectively and likely in other large newspapers.

order to report on its work." Part of that included Eisenbud's characterization that claims there were 24 megatons of fallout yield in the stratosphere was "scientific double talk." Not to worry, there were actually only 4,000 pounds of fallout from all nuclear testing, only half made it into the atmosphere, and it was "highly diluted with air." Questions HASL answered included whether fallout was heavier in some places. Readers were reassured that, except for a slight concentration near the test sites, for the deposition of fallout "otherwise the rate is uniform…"[932]

Given both HASL and the magazine were located in New York, the publishing capital of the nation, the article was likely prompted by Libby's ongoing attempts to sustain the increasingly unsustainable – the AEC's position that fallout from testing was a nearly irrelevant risk conflicted with the civil defense message one needed to take shelter from it in the event of war. Consumers who heard these mixed messages were confused and perplexed, even when they had funds to pursue such expensive courses of action as fallout shelters. Civil defense funding remained meager during the Eisenhower administration, a policy confirmed when the president chose to do nothing about recommendations in the 1957 Gaither Report, which called for massive construction of public shelter space, among other measures to deal with the new realities of nuclear war.[933]

Lack of government funding combined with Republican distaste for new government benefit programs did not seem to fully account for the lack of effort to encourage construction of private shelter space. Instead, in a demonstration of the sway nuclear absolutism continued to hold over strategy, 1957 saw two initiatives indicating many in the military command structure saw only more nuclear weapons as the answer to the threat their fallout posed.

Gimme Shelter? Fallout's Threat to Political Leadership Recognized

Eisenhower grew to recognize the consequences and implications of fallout and its relationship to overall national security policy in large part because of his own long experience with it, a sort of personal fallout history; his familiarity with its use for strategic intelligence purposes exceeded the scope of most of his advisers and contemporaries in government service. The Gaither committee served as a means for Eisenhower to put specifics on the table in order to demonstrate investment in mass shelter was a strategically untenable approach, thus providing a stronger empirical basis for Eisenhower's gut-level reaction to the problems posed by fallout.

[932] Donald C. Cooley, "Leukemia," *Better Homes & Gardens*, Vol. 35, No. 4 (April 1957), 240, 343, 395; "Bomb Dust Radiation," *Better Homes & Gardens*, Vol. 35, No. 5 (May 1957), 71, 172, 174, 179, 182.
[933] Snead, *The Gaither Committee*.

Having established through the Human Effects Panel the supraconventional effects of any massed use of thermonuclear weapons in themselves, exclusive of fallout, cast grave doubt on national survival, Gaither reinforced those terrifying conclusions by questioning the feasibility of defending against the extraconventional effects of fallout inevitably associated with the supraconventional effects found so desirable by military target planners. Gaither thus served to mark a squaring of the circle that began with GABRIEL. It was matter of more than political interest at the Pentagon, with fallout as a factor undermining what remained of the Air Force's illusive belief in the viability of victory in general nuclear war against the Soviets. Behind the scenes, Rabi's efforts to address the fallout problem combined with a presidential mandate to accomplish the task bore fruit of a different kind as the Air Force unlocked the gates to research on fallout's behavior in the stratosphere by means of its own U-2 fleet with a mission called CROWFLIGHT, a thread that will be picked up in the next chapter.

By mid-1957, the blinders excluding fallout from significant influence as a factor in policy discussions were off behind closed doors, with a certain sense of panic setting in that was low-key, but indicative of the pressures fallout was exerting more broadly upon the national security bureaucracy. A gathering storm of public opposition only added to the incentive for fallout to remain ensconced in secrecy as it had been for the previous decade; the Hedley Marston affair in Australia demonstrated the crumbling of this shield in the face of growing transnational scientific expertise in the sampling of radiation as it was transported through the environment.[934] At the 318th meeting of the NSC on 4 April 1957, NSC-5709/SNIE-100-5-57, "A Federal Shelter Program for Civil Defense" was discussed in detail. The NSC Planning Board stated it was "deeply troubled" at the prospect of "protecting the civilian population" in the event of nuclear war. Prior planning assumed evacuation of urban areas in the event of war, but the potential for massive fallout sweeping over evacuation routes and refuge zones made that a moot point, suggesting shelter in place was the best course of action for survival.

With "the full magnitude of the problem of radioactive fallout" understood, Robert Cutler pointed out the political conundrum the situation represented for the Eisenhower administration.

> Mr. Cutler then explained to the Council the serious dilemma that the Administration would find itself in if, when the issue [the threat posed by fallout] finally became clear [to the public] the administration had nothing to say one way

[934] Cross, *Fallout*, 9, 21-22, 152.

> or another with respect to a shelter program. This would put the Administration in an indefensible position.[935]

While the internal fallout anxieties of members of the administration were generally as well-hidden as their views on the nuclear intelligence derived from it, Cutler's statement on the potential for fallout to politically damage the president in multiple ways was clearly not far from all their minds given the levels of public controversy it generated even in the absence of the troubling data then flowing into the White House.

Libby's Striving Optimism Promotes Atmospheric Buffering

Efforts flowered to position the new American emphasis on development of small tactical nuclear weapons as a policy of restraint, particularly in regard to the belief smaller bombs meant reduced fallout. Willard Libby argued weapons of less than one megaton "deposit all of the radioactivities [sic] within a matter of days or weeks around the globe corresponding generally to the latitude of the test site." The AEC commissioner continued to insist on having it both ways, though, in his benignly optimistic view that larger yield explosions "shoot the bulk of their radioactivities so high that they take years to settle out."[936] Implicit in Libby's simplistic problem formulation was fallout either came down quickly – it might drift far from the intended target, but in a predictable manner – or would take many years to do so, with the bulk of its most dangerous radioactivity safely decayed and diluted before returning to earth. The former assertion was marginally true, something Libby knew, while the latter sounded like a plausibly appealing theory, but one requiring confirmation. Libby's hopeful hypothesis resulted in planning for several high-altitude test shots during the upcoming 1958 Pacific test series to inject specific tracer isotopes in order to measure the speed of the downward drift of fallout from the stratosphere.[937]

The *New York Times* did its part to manufacture public consent for tolerating radiation exposure by printing an unsigned opinion piece that supported Libby's sunny positivism on fallout. At the same time, it belittled Japanese government warnings to its citizens that the increase in fallout the Japanese attributed to Soviet testing should require consumers to take

[935] Foreign Relations of the United States, *1955–1957, National Security Policy, Volume XIX*, 462.
[936] "U.S. Experts Doubt Peril of Fallout," *Los Angeles Times*, 21 April 1957.
[937] TEAK (3.8 megatons, 1 August 1958, 252,000 feet) and ORANGE (12 August 1958, 3.8 megatons, 141,000 feet) were launched by rockets from Johnston Island in the Pacific. Spectacular light effects were visible in Hawaii. Both shots caused dramatic electromagnetic pulse (EMP) effects that interfered with radio propagation. Salted with specific isotopes, these two shots helped demonstrate that fallout stayed aloft for far briefer periods of time than first believed.

precautions in preparing food.[938] Libby published what the editorial referred to as "the first authentic studies ever made on the content in human bones of radioactive strontium-90, the most worrisome part of radioactive fallout."[939] The *Times* confused the "maximum permissible dosage" with the even more ambiguous "dose regarded as safe," demonstrating how the media, through erroneous simplification and repetition of disinformation further muddied the waters of assessing radiation risk, all while remaining largely uncritical of those who claimed the mantle of scientific authority about fallout in the service of official policy.

Certainly, one burning question in reporting on the research would be to ask about the basis of Libby's certainty about the safety of fallout.

> …we do know that the effect of radioactive fallout from nuclear tests is not, nor is it likely to be, the danger to the human race in this generation or any generation or in later generations which many people had been led to believe.[940]

On balance, in dismissing the possibility of risk from fallout, the *Times*' editorial board argued a point of view encapsulating the latest version of the nuisance theory of fallout – nothing here to see, now move along. The editorial's conclusion was the same as the military's – whatever health risk fallout from testing held, it paled into insignificance against the national security needs of developing nuclear weapons. Interestingly, by 1957 AFOAT-1 and others responsible for radiation safety within the U.S. military were in the process of becoming more forthright in internally acknowledging the existence of risks from fallout than either the AEC or the *Times* were, even though all came to the same conclusion testing must continue.[941]

However, the times were changing and fallout could no longer be dismissed as inconsequential. In 1950, there was no need to defend policy on fallout, but by 1957 fallout was a force to be reckoned with – and required the defense of policy about it in the press. The same edition of the *New York Times* that argued for the innocuous nature of fallout carried a letter to the editor from Norman Thomas, the American Socialist leader, who decried "the grave peril of ever-increasing radioactive fallout." Thomas supported "a monitored moratorium" on nuclear

---

938 "Fallout Is Not the Danger," *New York Times*, 21 April 1957.

939 Willard Libby, *Worldwide Effects of Nuclear Weapons: Project Sunshine* (Santa Monica: The Rand Corporation, 6 August 1953). ACHRE, *The Human Radiation Experiments*, 405. A declassified version of this report was released two days before the start of hearings on fallout in Congress on 25 May 1957. This was probably one of the first results of the 1957 revelation of Sunshine. It may be associated with a desire to cast this research as part of the 1957-1958 International Geophysical Year.

940 "Fallout Is Not the Danger," *New York Times*, 21 April 1957.

941 AFOAT-1, 1957 Unit History. AFOAT-1 undertook an internal study in 1957 to evaluate its own procedures to limit radiation exposures.

testing, pursuit of disarmament negotiations in the midst of such a halt, and holding the United States government as accountable as it desired the Russians to be in its framing of Soviet "atom diplomacy" as inimical. Thomas was careful to note the non-aligned, transnational nature of growing concern over fallout.

> What other people think is becoming ever more evident. The Pope has again expressed sympathy with opposition to further tests of nuclear weapons. The greatest scientists of Germany will have none of atomic experimentation…The Japanese government has repeatedly and vigorously protested both to Russia and now to Great Britain on nuclear tests…I could pile up further proof that the nations will not agree that it is only Russia which practices atom diplomacy.[942]

The 21 April 1957 *Times* editorial, and most likely Thomas' missive, too, were timed to address what the United States government saw as a threatening foreign scientific mission – the visit by Professor Masatoshi Matsushita, a scientific aide to the Japanese prime minister, to Washington, DC. There, according to the *Times*, he was "to plead his country's case for an end to nuclear weapons tests."[943] Demonstrating the reach of the "special relationship" between the United States and Great Britain was increasingly affected by the political fallout of fallout, Matsushita's mission was motivated in part to protest plans by the British to test their first thermonuclear device at Christmas Island in the Pacific.[944]

Secretary of State John Foster Dulles made a point of personally welcoming Matsushita into his home, even though the Japanese scientific envoy "had merely asked to see an officer of the Far East Bureau of the State Department." Dulles then explained to Matsushita "that the responsibilities of the United States in defending the free world made continuance of tests essential at present…" and that it was "impractical" to halt testing.[945] While this position was couched in terms of U.S. policy, under the circumstances, Dulles was in fact defending a joint position of the Americans and British. The Japanese protest to the Americans about the proposed Christmas Island testing followed on from their previous protests against British testing in Australia, which saw little coverage in the ever-parochial U.S. press, but which Dulles, the

---

[942] "Letters to The Times: Moratorium Declared Beginning of Genuine Disarmament," *New York Times*, 21 April 1957.
[943] "Fallout Is Not the Danger," *New York Times*, 21 April 1957.
[944] Robert A. Divine, *Blowing on the Wind: The Nuclear Test Ban Debate, 1954-1960* (New York: Oxford University Press, 1978), 120. The UK previously used Australia for its testing rounds, but the enormous fallout potential of thermonuclear weapons meant Australia, large and sparsely populated as it was, failed to provide enough isolation to test such high yield devices.
[945] Dana Adams Schmidt, "Dulles Tells Tokyo Envoy Atom Tests Are Vital Now," *New York Times*, 22 April 1957.

Pentagon and Eisenhower were quite aware of because of the close coordination between the two allies on nuclear intelligence, testing, and now running interference for each other in the press.

Balancing Risk versus Security

In contrast to both Defense and State's positions arguing for the worthy risk of fallout stood Libby's prevarications on behalf of the AEC, with Libby now all but officially declaring a closed case on the proven safety of atmospheric testing. Matsushita's discussion with Dulles suggested that outside the AEC, U.S. government representatives could no longer evade pursuing an actual determination on the risks fallout posed, instead of simply stating no evidence existed of a risk. In contrast to Libby's clumsy attempt at foreclosure on the subject, scientists now faced research questions about fallout that increasingly forced the AEC to deal with the problem as an open scientific question.

> [Matsushita] reported that Mr. Dulles felt it was up to the scientists now to prove or disprove the conflicting views as to the harmfulness of nuclear tests.[946]

It was an invitation already being taken up by the Japanese, in Australia by Hedley Marston in connection with British testing there, and in the United States by scientists outside the AEC and, in some cases, within Project Sunshine and elsewhere in the AEC's vast bureaucracy.

Portending further problems for the AEC as it increasingly lost control of the fallout narrative, another article appeared in the *New York Times* on 23 April 1957, marking an escalation in the problems the Commission now faced in dealing with the consequences of radiation's risk. At the annual meeting of the National Academy of Sciences, Dr. Bentley Glass, professor of biology at Johns Hopkins University, gave a presentation that initially seemed reassuringly positive for the AEC's position, but ultimately reinforced the argument that cumulative radiation posed a threat. Glass declared the risks of fallout from current military applications of nuclear power, short of war itself, in themselves were of "'of minor significance' from a genetics standpoint and 'need cause no further concern.'" However, Glass went on to emphasize the existing scientific consensus that risk was inherent in any amount of radiation, then threw a cautionary light on existing practices in medical radiology and the potential for widespread use of nuclear power generation. In his view, no single source of low-level radiation was inherently problematic, but the significantly increased overall exposure to radiation of

[946] Dana Adams Schmidt, "Dulles Tells Tokyo Envoy Atom Tests Are Vital Now," New York Times, 22 April 1957.

various populations underway at mid-century posed problems of uncertain, but definitely heightened risk as the rate of average individual exposures and body burdens increased.

> Dr. Glass estimated that man might be approaching 50 per cent of the permissible level of radiation recommended by the academy in a report on the hazards of atomic radiation…[suggesting] that it might be necessary…to revise it downward.[947]

Thus, Glass framed the fallout problem – whatever its risk actually was and even when testing fallout was declared as having no or small consequence in and of itself – as linked to questions about the safety of other forms of nuclear power amid recognition the cumulative dose an individual experienced was better indicator for most about the risks they faced from radiation. Many who made such comparisons, like Glass, seemed to believe that the public would be persuaded to accept the risk of fallout if couched in terms of its relative safety in comparison to other uses of nuclear energy and other, more common risks. In the context of official policy, this made a certain amount of semantic and argumentative sense. If the anxieties fallout created could be dampened by such assertions and superficial changes made in other government policies, then this approach might have been persuasive. However, events led public opinion in the opposite direction, much to the distress of the AEC and other civil nuclear power boosters as fallout's taint on the reputation of radiation spread to areas other than the use of nuclear weapons. While the argument here largely confines itself to the role of fallout in perceptions of radiation risk in relation to national security, public perceptions tend to generalize such argumentative differences, leading to the rash on fallout rubbing off onto more peaceful applications of nuclear energy. Glass' remarks, intended to lessen public concern about fallout, in fact spread concerns about fallout more widely to all aspects of nuclear energy. By the time the 1963 Limited Test Ban Treaty addressed the problem of fallout weakening public support for national security policy, this uncomfortable linkage between military and peaceful uses of nuclear energy was well established. In effect, fallout as a wartime effect during peace made the idea of tolerable exposures from peaceful nuclear power an oxymoron. There was no way to distinguish between "good" and "bad" radiation, just as one could not sense radiation without an instrument. AFOAT-1's mission was to distinguish between "their" fallout and "ours," but this was a distinction of little importance to most.

[947] John W. Finney, "Chief Atom Peril Seen in Peace Use," *New York Times*, 23 April 1957.

Just as Libby and Glass drew somewhat differing yet optimistic official and scientific lines in the sand on the issue of fallout risk, in April 1957 Dr. Albert Schweitzer, the 1952 Nobel Peace Prize recipient, issued a global appeal over Radio Oslo, demanding an end to nuclear testing in an address broadcast by shortwave radio and national networks in some fifty nations. The philosopher, doctor, musician, and missionary, in failing health but determined to "awaken public opinion," argued humankind faced "the gravest and most terrible danger." Schweitzer rejected the positions of those like Libby and Glass as morally incapable of "[taking] responsibility for the consequences it might have for our descendants." Pulling no punches, Schweitzer charged "official and unofficial sources" of downplaying the potential for harm from fallout. The widely distributed speech was unheard by most Americans, as the national broadcast networks failed to pick it up and the press did little more than the brief, limited reporting about Schweitzer's call.[948]

Schweitzer was well-known enough among the intelligentsia, religious, and social service communities that the *New York Times* covered the story on its front page, along with a photograph of the Nobel prizewinner.[949] With the passing of Gandhi and Einstein, Schweitzer's prestige as a global champion of human rights perceived as neutral and unaligned with either East or West, as well as his fame as a physician, made him a potent spokesperson who extended the reach of powerful forces of political, social, and cultural pressure fallout generated against institutions involved in the development and testing of nuclear weapons.

Thus, while it would have been easy enough for American officials to ignore Schweitzer's appeal, they instead chose to take him on directly on the issue of fallout. Willard Libby made a very public point of issuing an eight-page open letter in response to Schweitzer. Libby insisted that "Schweitzer's appeal was not based on the latest information on radioactive fallout," in a follow-up story reported on the *New York Times* front page, but graced with no hagiographic image such as Schweitzer enjoyed. Libby's tone was, however, now concessionary and stood in marked contrast to his earlier statements, including a bit of back-pedaling in how he had described the risk of fallout just days before Schweitzer's appeal. Libby now conceded that he was referring to "observable effects" when he staked out his previous absolutist position on the safety of fallout. Libby disingenuously called on Schweitzer to join him in balancing the risks

---

948 "Schweitzer Urges World Opinion to Demand End of Nuclear Tests," *New York Times*, 24 April 1957.
949 Divine, *Blowing on the Wind*, 121-122.

of fallout against the need to defend "freedom loving people everywhere."[950] For a scientifically observable phenomenon that was otherwise largely invisible and only demonstrated its full range of effects over a long temporal scale, Libby's fallback position amounted to ignoring the potential lethality of an ingested poison because the patient was not yet demonstrating signs of its toxicity.

The bulk of Libby's argument assumed averaging a largely even spread of fallout over the affected landscape, a theory of describing fallout dispersion long disproven by AFOAT-1's experience in tracking fallout plumes to conduct sampling for intelligence purposes. This was a fact Libby was likely familiar with, even if not fully briefed into the work of such a sensitive program.[951] While there was some mixing and dispersion of fallout plumes, tracking these concentrations downwind was possible and their tracks were distinct and predictable enough based on observing the movements of winds carrying them. The Air Weather Service did this daily in support of AFOAT-1 sampling operations throughout the 1950s. Fallout's travels through the ecology once back in the surface environment remained little understood; the problem was that fallout dispersed briefly after a nuclear explosion. Once loose in the environment, the tendency of various natural processes was to re-concentrate it through diverse pathways in the environment with the passage of time. Political and diplomatically, given the United States sent fallout elsewhere without asking anyone's permission, Libby's assertion that people should think more positively about it seemed like a rather forced bargain. It was a position undertaken largely without research, except for the word of Libby and the AEC, essentially public relations fluff dressed up as scientific authority. That was to soon change.

1957: HARDTACK

The AEC publicly announced the pending HARDTACK test series for 1958 on 29 May 1957, the day after the first PLUMBBOB series shot in Nevada. Leaving no doubt testing would continue, the statement emphasized in particular the necessity of the next test series in helping develop "clean" weapon designs. It was only basic commonsense politics to mouth the words needed to reassure the nation and the world that the United States was making every possible effort to minimize fallout. The AEC marketing effort implicitly argued to the public that the best

[950] Edward L. Dale, "AEC Head Says Dr. Schweitzer Errs." *New York Times*, 26 April 1957.
[951] Libby's development of the krypton-85 monitoring technique was described earlier. Even as an AEC commissioner, it is difficult to determine what other details he might have known about LRD beyond being generally familiar with the AFOAT-1 mission.

way to limit fallout was to make more of it and study it. Still, the constraints fallout imposed were the order of the day. On 1 May, the AEC assessed "that in view of the present climate of world opinion, it would be unwise for the total fission yield of Operation HARDTACK to exceed that of Operation REDWING [the 1956 Pacific series]."[952]

General Starbird, Military Liaison Committee (MLC) chair and the Pentagon's primary representative at the AEC, was clearly uneasy about the surge in negative public opinion and the consequential need to address the calls to limit fallout from testing itself by proactively shaping the discussion.[953]

> I feel that we will have to give immediately before HARDTACK some indication as to how clean our weapons are. I do not believe this should be done until just before HARDTACK. We should use it at that strategic time to help overcome opposition to HARDTACK."[954]

This mistaken logic, which privileged official control of the narrative by virtue of governmental capacity to rebrand at best incremental design changes in nuclear weapons as consequential and "clean," failed to reflect that, like fallout itself, once created the government no longer had exclusive control of fallout's own narrative. The very fact that Starbird implicitly acknowledged how fallout bent his intentions and will through the constraints it increasingly placed on nuclear weapons was also important as an indication that some in the military were coming to terms with the need to be far more circumspect in choosing a way forward. What Starbird saw as obvious and useful low-hanging fruit needed to reassure a public increasingly anxious about the insecurity fallout was bringing into their daily lives, others in the military found to be an irritating diversion from the task at hand. Thus, the chain of secret decisions to limit total fission yields beginning with REDWING was said to cause many weapons designers

---

[952] Hansen, *Swords of Armageddon*, IV-272, -276. The REDWING total yield under its "energy budget" was 20.82 megatons, http://nuclearweaponarchive.org/Usa/Tests/Redwing.html; pressures to add test shots in case it was the last ever test series saw HARDTACK I total 35.6 megatons, http://nuclearweaponarchive.org/Usa/Tests/Redwing.html.

[953] Hansen, *Swords of Armageddon*, IV-271, -273. The AEC considered an alternative location for HARDTACK's two high altitude shots, but Defense objected to both the cost and the potential for political opposition. The proposed site, Taongi Atoll, provided a wider safety zone for islanders. It would also require notice to the United Nations Security Council to close the area to shipping for safety purposes, but along with those factors DOD cited "possible adverse public reaction" because of concerns about testing fallout as the other significant problem with the idea.

[954] Ibid, IV-273.

and military staff to rebel against even the slightest imposition on the their quest for dramatic explosive power, regardless of the consequences and risks.[955]

Fallout from Fantasy to Fact

The need for secrecy associated with fallout was self-reinforcing by 1957. If the limited fallout generated by testing was proven risky, it would call into question war plans assuming, regardless of the military's ability to limit Soviet attacks on American targets, that the United States would detonate thousands of nuclear weapons against Russian targets, generating a rain of global fallout resembling the scenario outlined in the popular 1957 novel, *On the Beach*.[956]

While technically questionable in several areas, including its 100 percent mortality rates, the novel's narrative was compelling and plausible to a public primed on what they read and heard about fallout. One may quibble with its science and politics, but *On the Beach* was a masterfully timed example of transnational art interacting with reality. The plot served as a conceptual channel overcoming transnational communication barriers. *On the Beach* modeled how to think about or view fallout in a way that became not only widespread, but deeply rooted in many cultures in a rapidly globalizing world. Published in 1957, given the global timeframe needed for the process of promotion and marketing, in terms of its impact *On the Beach* was widely read in 1958 in connection with the often disturbing news of the latest nuclear and military developments.[957]

For those in the Air Force still ambitious for higher yield weapons, among the chief irritants besides AEC Commissioner Murray was their commander-in-chief. Finally responding in late May 1957 to congressional inquiries on the matters Murray raised about fallout, Eisenhower demonstrated both his expectations of progress and a certain continuing naivety in his dependence on Strauss for advice on AEC progress in controlling fallout.

> Most recently, we have learned that certain of them can be made in such a manner that radioactive fall-out is very greatly minimized. The tactical usefulness of this latter development is known to you… I feel that our large weapons (incidentally, now susceptible of being relatively the cleanest in the sense of fission product

[955] Herbert York, *Race to Oblivion: A Participants View of the Arms Race* (New York: Simon and Schuster, 1970), 12-13.
[956] *On the Beach* was first serialized in four parts in April 1957 editions of the London *Sunday Graphic* under the title "The Last Days on Earth."
[957] *On the Beach* was rewritten into a movie script and the resulting, likely more widely viewed film debuted in 1959.

> yield) are large enough… cleanliness, which, as of now at any rate, does not yet apply to weapons of small size and yield.[958]

Citing his view on the matter, the president specifically rejected any plans to test weapons larger than CASTLE BRAVO's yield and bluntly stated that if any such testing was contemplated, it would require his personal review and approval. Despite the secrecy associated with the Air Force's plans for 60 megaton class weapons, the Washington pressure-cooker was apparently channeling just such rumors, which Eisenhower wanted put to rest. The increasing congressional interest in fallout transmitted via the JCAE was a situation brought about largely because of legislators' fears of fallout's potential for increasingly debilitating effects on political support for nuclear weapons, as well as in response to the increased agitation of their constituents on the issue.[959]

Chuck Hansen nonetheless offered a stark judgment on the social effects of nuclear weapons and fallout, arguing that "the politics of 'clean' weapons could be just as powerful as the bombs themselves."[960] While Hansen's comment shared the established frame of viewing fallout's role primarily through the social results of its influence, rather than as a result of its empirical effects, his derivation posed the frequently unacknowledged and always uncontrolled spread of their fallout against the obvious explosive power of nuclear weapons that generated it as an inherently self-limiting dialectic of power, a point of view held in common by this project.

The U-2 Begins Poking Gaps in the "Gaps" Controversies

The American public and, for the most part, Congress, too, was led to believe that very little was known about Soviet strategic forces during the nineteen-fifties. While there were significant limitations, in fact the general scope of the potential nuclear threat was well-defined thanks to the effectiveness of AFOAT-1's krypton-85 monitoring. Before ready access to aerial

---

[958] Letter dated May 27, 1957 to Honorable Sterling Cole, Chair, Joint Committee on Atomic Energy, House of Representatives, from President Dwight D. Eisenhower; cited in Hansen, *Swords of Armageddon*, IV-274-275.

[959] Cross Reference Sheet: Letter from James Killian to John F. Kennedy, 8 August 1958, Eisenhower Library, Central Files, Central Cross-Reference File, Box 88. John F. Kennedy's constituency in Massachusetts was particularly interested and involved in issues surrounding nuclear weapons, radiation, and fallout. The presence of the Massachusetts Institute of Technology and Harvard included a critical mass of intellectuals and subject matter experts, as well as a wider community much more likely than the average American to have an active, participatory interest in matters such as peace and disarmament, as well as international relations and the management of advanced technologies. One example of this was Kennedy's Senate office forwarding a letter from the Greater Boston Council of the United World Federalists to James Killian's office inquiring about release of the report authored by Killian that evaluated the feasibility of a verification regime in support of a test ban. Killian advised Kennedy that "release of this report is not feasible at this time."

[960] Hansen, *Swords of Armageddon*, IV-275-276.

and spaced-based imagery began with U-2 overflights over the Soviet Union in July 1956, estimates of Russian strategic bomber strength varied. In what was essentially the public side of the secret interservice intelligence conflict, Air Force supporters began arguing in support of SAC's enormous buildup of thousands of bombers as needed to offset a presumed Soviet advantage, which was termed the "bomber gap."[961] The same basic argument was later recycled into a "missile gap."

Neither was the case, yet claims of significant American military weakness were politically explosive. One of the first public indications of the bomber "gap" controversy's potential political ramifications came during House hearings on the 1958 Pentagon budget held in February 1957, as the first take from U-2's intelligence imagery of the Soviet Union was secretly and without direct attribution incorporated into the latest NSC estimates of Russian strategic forces strength provided to Congress. Secretary of Defense Charles Wilson, Air Force Secretary Donald Quarles, and the new Chair of the Joint Chiefs of Staff, Air Force General Nathan Twining, were interrogated about these revised intelligence estimates of Soviet nuclear strategic strength made after Congress recessed prior to the 1956 election. Incensed over the lack of explanation given by the Pentagon on the basis for the changed numbers, Representative Daniel Flood (D-Pennsylvania) directly questioned Twining about the timeline of the revisions.

> What is the earliest date the Air Force and the Department of Defense, either or both, knew that the intelligence was fifty percent wrong on the heavy bomber figures on which the current fiscal budget was predicated?

Twining hemmed and hawed without letting Flood pin him down or providing any substantive reason for the revision or the reasons behind its timing. In fact, Twining seemed to insist that any change was merely semantic, rather than a sharp reduction from previously estimated growth the numbers seemed to indicate.

> [T]here is no change in our estimate of the number of these modern long-range bombers the Soviets could provide for their forces during the next two years. The change that has been made is to revise our estimates of long-range bomber strength today and in the near future.

[961] John Prados, *The Soviet Estimate: U.S. Intelligence Analysis and Russian Military Strength* (New York: The Dial Press, 1982), 38-50.

The congressman shot back that Twining's explanation was "not responsive." Air Force Secretary Quarles next tried to mollify Flood, while confirming the changes made were at the behest of the junior service.

> [T]hroughout the time of congressional action, we believed that the testimony given…on the Air Force was the best summary of our intelligence and there was no intelligence to the contrary that came to my attention.[962]

Quarles then insisted that any revisions made were being provided to Congress at the first opportunity, to which a clearly irritated Flood retorted, "That is not an answer."[963]

In reality, the need to keep the U-2 itself secret was not the only or even the root cause of a lack of explanation for the sharply lowered estimates of Soviet strength. The 4080th Strategic Reconnaissance Wing at Laughlin AFB, Texas (near Del Rio) was undertaking training flights and began its operational missions later that year in the aircraft; although low key, the unusual plane was on almost daily display operating out of the base on the Mexican border.[964] While the secret overflights of the USSR by the CIA's U-2 threw a new, more accurate light on estimates constructed from older, faulty intelligence estimates, the primary basis of Air Force estimates of Soviet nuclear strength remained the krypton-85/MUSIC data generated by AFOAT-1 – "…the Air Force was the best summary of our intelligence and there was no intelligence to the contrary…" The revisioning narrative here suggests the need for more attention to the paradigm the U-2 overthrew – the Air Force's distorted analysis of AFOAT-1's otherwise accurate estimates of Russian plutonium production. This obscured the original source and budgetary import of the intelligence overthrown by the U-2 from historians, just as it proved useful in concealing the aircraft's full narrative from Congress in 1957.

The U-2 was born as a strategic reconnaissance system in large part to fill in the gaps in Soviet force structure, delivery systems, their true numbers, and exact locations that the Air Force's use of AFOAT-1's otherwise reliable intelligence data failed to provide. Think of the AEDS as a camera with an excellent zoom lens, but a very narrow field of view. As a first

---

962 Prados, *The Soviet Estimate*, 47.
963 Ibid.
964 4080th Strategic Reconnaissance Wing, 1957 Unit History, Air Force Historical Research Agency, Maxwell Air Force Base, Reel# 960. Chris Pocock, *50 Years of the U-2: The Complete Illustrated History of the "Dragon Lady"* (Atglen, PA: Schiffer Military History, 2005), 46. The first Air Force U-2 pilot was checked out in November 1956 at the CIA base at Groom Lake, Nevada. The Air Force's first 20 U-2 aircraft arrived at Laughlin AFB, Texas and training started during 1957. The unit received warning orders for CROWFLIGHT, its high altitude sampling mission, in October 1957.

generation technical collection system, the AEDS was very good at a very narrow set of missions, but was quite limited in its ability to provide data that could synergize with other sources to provide unique insights into other important aspects of Soviet strategic forces, like delivery systems.

The U-2's CIA mission was to discern at least the outlines of Soviet intentions as well as to better define capabilities of the immense nuclear arsenal it was known to have accumulated by 1956 and that the krypton-85 program revealed was well within its grasp, resolving that question in little more than year. The answer was, while apparently flush with the fissile material required to make weapons, the Soviet strategic threat was hobbled by its incapacity to project power effectively because of the deficiencies and limited numbers of its strategic bomber fleet and other delivery systems. If there was a bomber gap, the Soviets had it.

One reason for the conflict between Congress and the Pentagon was, of course, the very typical motivation within bureaucracies to hide their failures with new promises of success. It was impossible to explain the change in estimated Soviet strength without going into more detail about the predominant role played by AFOAT-1's data on which the earlier estimates were based. This stark, secret reality contrasted with the publicly hegemonic postwar American political consensus of anxiety that often simplistically defined the overarching national security mission as "avoiding a nuclear Pearl Harbor."[965] The Air Force, dependent on nuclear weapons, saw a diminution of its role take shape in the success of the CIA's U-2 program, leading it to acquire its own U-2 fleet after initially rejecting the aircraft as unsuitable.

These changes came at a time already fraught with tension over organizational turf between the Air Force and the CIA. The first U-2 overflights of Russian territory in the summer of 1956 provided enough hard photographic evidence for the CIA's analysts to issue a report in November 1956 arguing for substantially lower estimates of Soviet bomber strength. The U-2 provided an alternative source of quantitative data on Soviet nuclear strength for comparison with data provided by AFOAT-1's tracking of Russian fissile material production.[966] The problem was that the adjusted estimates of Soviet bomber strength, while still classified, were

---

[965] The trope of a looming "nuclear Pearl Harbor" should not be underestimated for its persuasive power among a generation with World War Two fresh in its mind amidst a domestic politics driven by fear of Communism. The *Los Angeles Times* editorial board excoriated Stevenson for raising the issue of limitations on testing at all during the 1956 campaign using the exact image of Pearl Harbor to question his competence to lead the nation. "The President Replies to Adlai," *Los Angeles Times*, 7 October 1956.
[966] Prados, *The Soviet Estimate*, 18-23, 38-50, 67-95, discussed the virtues and vices of the national intelligence estimate process, as well as the bomber and missile gaps.

provided to Congress in the middle of the election break without complete attribution as to their source or justification for the significant reduction in estimated Soviet strength. Thus the more accurate, but substantially lower numbers provided by the CIA, rather than resolving the problem for lawmakers, added considerable fuel to a growing bi-partisan fire over the relative balance of power between the two superpowers. While the drumbeat of anxiety over purported Soviet capabilities provided ample ammunition in the battle for higher Pentagon budgets, the secrecy shrouding U-2 imagery fed questioning about the real capabilities of intelligence assets and their estimates of Soviet strength in Congress, which helped drive the hungry spiral of escalating defense budgets Eisenhower denounced in his farewell address in January 1961.

Without access to the same information Eisenhower held, the seeming sudden closure of the "bomber gap" raised eyebrows in Congress over whether the East or West held the lead in the nuclear arms race, an uncertainty that publicly festered for two years, expanding to include a similarly-supposed "missile gap" with the launch of Sputnik. Despite the source of these "gaps" in analytical gaffes, by the time of the 1960 presidential campaign, Democratic and Republican camps clashed over whether enough was being done in general to counter this concocted illusion of growing Soviet technical prowess.[967] The issue of which nation held the lead in missile technology was clouded somewhat by the poor test performance of several ambitious U.S. missile systems, creating considerable public anxiety about the status of each program and raising questions about which nuclear power would first field a credible ICBM capability. This was a race the United States ultimately won, but which was very much an open question as 1957 drew to a close. Behind the scenes, the explanation was simple: intelligence produced by the U-2 provided the first empirical data that materially contested earlier estimates of Soviet bomber strength long derived almost exclusively from data produced by AFOAT-1.

---

[967] A contextual factor was the persistent lobbying of the Air Force Association for funding the service's full budget requests. Such appeals to Congress during the Cold War were often couched in terms of the unknown nature of the Soviet threat. As Chapter Three related how fallout information was withheld from Congress because of fears within the AEC that it might engender more fundamental questions about nuclear weapons, some Congressional ignorance was purposefully cultivated for political, as well as security reasons. Later, this constructive ignorance could be exploited as an unknown portrayed as best addressed by funding appropriations. Given the history of nuclear intelligence success against the USSR, consider the comparisons made in the appendices here between it and the United States. The build-up of SAC's bomber and missile forces might have been substantially altered if the relative American nuclear superiority that prevailed through the Fifties and into the early Sixties was known to Congress, instead of only to Air Force leadership, along with a few carefully cleared personnel within the White House and other executive branch agencies.

Imagery: A New Generation of Intelligence

Thus, from July 1956 on, the CIA's clandestine U-2 overflights searched Soviet skies to locate the highest priority targets – nuclear installations of all types – as well as sought to confirm the actual strength of Soviet bomber forces and the state of its missile program.[968] Remarkably, despite the best efforts of the CIA assisted by fixes from AFOAT-1 infrasonic data, by this late date the exact site of the Soviet testing ground in Kazakhstan was not yet firmly fixed. The interagency Ad Hoc Requirements Committee placed it, along with several other nuclear sites, at the top of its list of priority targets for the CIA's overflights of the USSR.[969] The CIA's Henry Lowenhaupt noted the location of what was eventually identified as the Semipalatinsk testing grounds, the Soviet equivalent of NTS, was only known within about thirty miles. This estimate provided indication that AFOAT-1's seismic network, had not yet fully benefiting from the vast expansion in scientific knowledge of regional geology it was then sponsoring in the academic community.[970] At the time, the U-2's best cameras could only deliver views of a strip about five miles wide when operating at altitude, posing the chicken-or-egg conundrum of needing fairly exacting coordinates in order to improve the chances of precisely photographing the location of an as yet unknown site.

In July 1957, Lowenhaupt asked Dr. Donald Rock, one of Doyle Northrup's assistant technical directors at AFOAT-1, for an averaged location of the five largest seismic signals collected from Soviet tests conducted there. Lowenhaupt used this spot as the target center in order to align the U-2's flight path over it to provide the greatest coverage on this leg of its route.[971] Lowenhaupt was aided somewhat in choosing likely targets by images taken from the limited yield of useful photographic obtained from the 1955 GENETRIX balloon reconnaissance

[968] Although the first year of overflights began in July 1956, they were quickly halted after five flights into the USSR from the west were detected, as a well as a sixth penetration from the south. Eisenhower ended the initial effort to evaluate the program and it did not resume flights over Soviet territory until August 1957. Flights continued against the bordering Warsaw Pact nations during this time. These first flights concentrated on the immediate priorities of confirming potential targets for SAC in the event of war.

[969] Chris Pocock provided a useful overview of the early U-2 overflights, "The Early U-2 Overflights," http://www.coldwar.org/articles/50s/early_u2.asp.

[970] Major investment in seismology was just beginning in 1957. The RAINIER test at NTS anticipated the potential need for underground testing, but provided a baseline of existing capabilities more than being a test of a more sophisticated system. Edward Teller claimed RAINIER was done to gather the first info needed to test what became known as the Teller-Latter decoupling theory. Teller credited David Griggs with actually suggesting the idea in 1956 in anticipation testing might be forced underground. Teller, *Memoirs*, 443. The larger part of investment in support of seismology occurred between 1958 and 1963, as the Joint Chiefs used the need to know more about seismology as a means of resisting the pressure to pursue a complete ban on testing.

[971] That mission substantially accomplished, it was notable that attention quickly shifted to the highest priority targets in advance of the second flurry of overflights.

missions. These balloons carried cameras, and perhaps sampling equipment, across the USSR and the People's Republic of China for recovery by the U.S. in the Pacific.[972] Gregory W. Pedlow and Donald E. Walzenbach archly observed the miniscule "success" rate of the 1955 GENETRIX flights; less than seven percent out of 516 flights produced any photograph with useful intelligence value. Moreover, the clandestine lighter-than-air flights, supposedly concealed under the cover story that the balloons were engaged in "weather research" underway in support of the upcoming 1957-1958 International Geophysical Year, frequently were shot down or otherwise fell to be recovered and displayed as captured trophies to the world press, suggested the Russian and Chinese governments involved were likely just as sensitive to the prospect of aircraft overflights. Despite these failures, GENETRIX provided important information on Soviet anti-aircraft defenses that was of use in designing electronic countermeasures for the U-2 and other Air Force aircraft. A bar in the balloon's rigging happened to resonate at the frequency used by the primary Soviet surveillance radar, so the flights provided unexpected opportunities to plumb signals from the Russian air defenses it reflected, indicating the probable location of the radars..[973] Seemingly far afield for the topic at hand here, it was an impressive example of the synergistic benefits derived from the close association of data with imagery that became a hallmark of American second generation technical collection systems that eclipsed the capabilities of first generation system like the AEDS.[974] In locating and capturing the imagery of actual targets, associating this data with location, and providing a contextual overview of the target defense, a comprehensive set of target data emerged to guide SAC's war plans staff.

In the end, the CIA's U-2s played – and eventually lost – the cat-and-mouse game with Soviet defenses during a period of great diplomatic effort for arms control between the two superpowers. The shoot-down of Francis Gary Powers brought this hopeful diplomatic interlude to a sudden close in the last year of Ike's presidency. Eisenhower understood the luck of the U-2

[972] GENETRIX balloon operations were not the first for AFOAT-1. The MOGUL program to research upper atmosphere sound reproduction included the Roswell incident in the late 1940s. Nor were they the last, with the ASH CAN program that gathered debris samples from the stratosphere in the late 1950s.
[973] Gregory W. Pedlow and Donald E. Walzenbach, The *CIA and the U-2 Program, 1954-1974* (Langley: CIA Center for the Study of Intelligence, 2004), 85-88. The TOKEN (NATO codename) radar operated in the 91 centimeter S-band.
[974] Pocock, *50 Years of the U-2*, 58. Pocock noted that CIA analysts often returned to the same imagery multiple times. When prompted by new information developed from previous analyses, this in turn generated fresh information by pointing to previously overlooked evidence that could be found in older photographs.

pilots was on borrowed time as Soviet air defenses improved. When it ran out in May 1960, it was two years past the time when the CIA warned Eisenhower the aircraft had become vulnerable to Soviet defenses.[975] Ike's reluctant determination in gambling to send the aircraft back again and again was not sparked by a simple desire to gather general intelligence on the Russians, although it did that admirably. Instead, the U-2 flights continued as the president sought to specifically resolve the Air Force's consistently high estimates of the Soviet stockpile with U-2 imagery demonstrating the weakness of Russian forces, while providing better target data for those forces it was able to locate.

The Furry Hat that Came in From the Cold

The CIA used other ingenious methods, like interviews with returning Germans and other refugees, to develop leads to locate nuclear facilities in the Soviet Union. Most significant was an example of the telling importance of scientific intelligence even when using suitable human sources. A returning refugee tailor who had worked in Tomsk brought a fur hat with him when repatriated to the West in 1956. His CIA debriefers forwarded the hat to AFOAT-1 (not AFTAC, as Lowenhaupt misstates, which did not come into existence until 1959.) Analysis provided suggestive results for Lowenhaupt to utilize in suggesting targets for the CIA overflights:

> … its exterior surface contained 50 parts per billion of uranium that was slightly, but definitely, enriched in the U-235 isotope. Since no U-236 was detectable, the uranium was not from fall-out, nor had it been through a reactor. Additional analyses for plutonium, radio-iodine, and separated lithium isotopes were all negative… The evidence was against its being a reactor with associated chemical plant or a lithium isotope separator. I made my target a U-235 separation plant and centered it on the spot where the German tailor had seen 12,000 prisoners go to work.[976]

This was especially significant, as detection of uranium separation facilities was a far tougher nut to crack for long range detection than locating evidence of plutonium production reactors or nuclear explosions. The limited effluents from uranium separation do not travel as indiscriminately as krypton-85 or iodine-131 do, so AFOAT-1's techniques of direct measurements of environmental samples were far less effective in locating such plants. Prior to the U-2's imagery, uranium enrichment facilities could only be located by means of less distinct indications such as provisions made for use of large amounts of electric power, vast new

[975] Pocock, *50 Years of the U-2*, 61, 71.
[976] Henry Lowenhaupt, "Ravelling[sic] Russia's Reactors," *Studies in Intelligence*, Vol. 16, No. 4. (Fall 1972), http://research.archives.gov/description/7283843.

complexes under roof, etc. Here was one of the rare cases where human agents provided telling evidence for nuclear intelligence from the USSR, but the findings still depended on exacting laboratory work to reveal the full implications of what the source offered, yielding facts most likely unknown to the person involved. Ultimately, such meager opportunities were largely eclipsed by the bounty of overhead imagery.

In an earlier *Studies in Intelligence* article, "Mission to Birch Woods," Lowenhaupt partially documented AFOAT-1's support to the CIA in developing this critical information to direct the U-2 flights.[977] One leg of the CIA U-2 mission on 22 August 1957 was charted to take the U-2 directly over the center of the averaged location of the seismic signals provided by AFOAT-1. As with the hat bearer, CIA Detachment B (Lahore, Pakistan) pilot Jim Cherbonneaux was not cognizant of the target Lowenhaupt hoped to photograph.[978] Once over the target, having flown his training missions in the plane out of the CIA's "ranch" at Groom Lake (known later as "Area 51") adjacent to NTS, Cherbonneaux recognized what was on the flight-track below as the U-2 soared more than 70,000 feet overhead: a shot cab similar to what he saw erected before tests at NTS in Nevada. Lowenhaupt doubted that "anyone thought seriously about flying into a nuclear test." But that was what nearly happened. The shot cab seen by Cherbonneaux was for a much smaller device shot less than a week later, but four hours after the U-2 cleared the area an air-dropped test (Joe-41, 520 kilotons, 22 August 1957) detonated.

On 21 August 1957, the day before location of the Semipalatinsk testing ground, another U-2 mission was vectored against the Tomsk location suggested by the fur hat. Its film showed an immense installation covering some 40 square miles. Thus within two days in the summer of 1957, the groundwork laid by AFOAT-1 was used *in conjunction with* the CIA's U-2 to finally track back and confirm the locations of Semipalatinsk and Tomsk. Lowenhaupt recalled the excitement accompanying location of the Soviet facilities.

> Allen Dulles is said to have exclaimed jubilantly, when he heard the news, "You mean you really did know that something atomic was going on 'way out there in the wilds of Siberia!'"[979]

---

[977] Peebles, *Shadow Flights*, 189-190. Ironically, after playing a critical role in the operational start-up and initial training of the both the CIA and Air Force U-2 programs, the "Ranch," as it was called then, was shut down repeatedly by fallout drifting in from the PLUMBBOB test series at NTS. Later, it became more infamously known as "Area 51." On 11 June 1957, Colonel Nole of the 4080th SRW led three U-2s on a flight from the Ranch to Laughlin AFB, Texas, initiating the independent Air Force U-2 program some 11 months after the first CIA penetration flight over the USSR.
[978] Pocock, *50 Years of the U-2*, 57.
[979] Henry S. Lowenhaupt, "Mission to Birch Woods," *Studies in Intelligence*, Vol. 12, No. 4. (Fall 1968).

Some argued the Agency at times placed itself more at the center of things than warranted by the evidence, failing to give others proper credit.[980] It took ten years and resources beyond the Air Force's own, but LeMay at last could be sure of the location of some of his most important targets. AFOAT-1 succeeded wildly, but the coverage gaps it left pointed toward the ensuing success of a new generation of imagery systems even as it provided them with important leads to focus upon.

1958: Caught in a Lie

It was unclear when Eisenhower found out that his statements about significant progress being made on the fallout problem were not supported by the facts, but within a year it became clear a discrepancy existed about what had been represented to him as fact about the status of "clean" weapons. This realization appeared to take place in between when HARDTACK I was concluding in the Pacific and HARDTACK II at NTS was poised to begin. In the middle of an even more intense public controversy over fallout just a year later, an anonymous member of the NSC staff prepared a summary of Eisenhower's previous remarks as a "Clean Bombs" briefing paper.[981] The usually ineffective OCB, while recently quiescent on nuclear issues, suddenly found "the major problem before the OCB Working Group is the current and continuous public discussion of the effects of nuclear fallout."[982] With the results of PLUMBBOB in hand and HARDTACK again plowing the same rough ground, this heretofore unnoticed "clean bomb" gap was more substantial than either the bomber or missile "gaps" ever were.

At HARDTACK, longer term goals to limit fallout again contributed to increased short term fallout by virtue of efforts to rush as many designs as possible through the gate before testing ended; along with the AEC's practice of adding tests of "clean" designs to the schedule, rather than substituting them in place of scheduled dirty shots, the shot list ballooned with last minute additions. In the end, rough calculations of fission yield at HARDTACK showed that it far exceeded, at 12.5 megatons fission yield, the 2.5 megatons fission equivalent yield originally thought to be available if the series were held to only the fission yield calculated to not increase

[980] The story of these successes was, however, largely hidden for decades until post-Cold War declassification made these articles publicly available. Lowenhaupt's 1968 article clearly credited AFOAT-1 for assistance tracing the location of Soviet nuclear facilities.
[981] "Excerpts from Presidents' News Conferences, Clean Bombs," Eisenhower Library, White House Office of the Special Advisor for National Security, NSC Briefing Notes, Box 2.
[982] Memorandum from Richard Hirsch to F.M. Dearborn, "Information Relating to Nuclear Weapons," 5 June 1957, Eisenhower Library, White House Office of the Special Advisor for National Security, OCB, Box 4.

total atmospheric radioactivity following decay of fallout from previous American test series.[983] What was not understood at the time about the estimated 2.5 megaton fission yield deposition rate was that, based on early returns from CROWFLIGHT in 1958 and 1959, it apparently was later found that the actual deposition rate was roughly four times as much, around 10 megatons of fission yield a year.[984] While that could have been considered good news for Starbird and Libby's efforts to squeeze in as many shots as possible, in fact it was bad news for Libby's theory that the stratosphere acted as a cooling reservoir so that fallout decayed before returning to earth. The accelerated deposition rate was even worse news for humanity, too, bringing strontium-90 back to earth much more quickly than originally believed. Unmentioned because of Project's Sunshine's primary focus on strontium-90, the accelerated fallout deposition had an even greater effect on shorter-lived isotopes. Those with half-lives of days, weeks, or even a few months, thought to for the most part decay safely in the sky under the original slow deposition model, would arrive in much larger quantities with the 400% increase in deposition rate.

Late 1958 into 1959: Critical Mass

Signs of impending change were everywhere, even as testing by East and West continued at a brisk pace during 1958. As HARDTACK I wound down in the Pacific and preparations were underway for HARDTACK II in October at NTS, behind the scenes Eisenhower maneuvered to gain consensus from the Pentagon and State in order to implement a temporary moratorium while negotiations on a permanent test ban agreement in Geneva edged forward. State worried "the political situation in the UN and the public opinion problem in Allied and neutral countries" made an agreement imperative. The Department of Defense supported a proposal, but only if tied to a fissile material cutoff and only down to the limits of a detectable signal, while leaving open the option to test below that minimum. The Joint Chiefs personally opposed any change in existing policy, while the AEC sought a 1 megaton atmospheric test yield annual limit it hoped would ensure no net additional radioactivity was added to the existing reservoir of atmospheric fallout.[985] The next day, General Twining followed up for the JCS with a memo for the Secretary

[983] Hansen, *Swords of Armageddon*, IV-313. The distinction between fission and fusion yields is often elided. Inclusion of fusion yield makes a reference to the fallout it produced seem more ominous. Its omission under the assumption that induced radioactivity is largely irrelevant elides the serious nature of the nonetheless far more than substantial radiation usually associated with thermonuclear weapons.
[984] See discussion in Chapter Four, 391-399.
[985] "Summary of Meeting Held in the State Department from 4:00 to 6:20 P.M., on August 13 [1958]," Eisenhower Library, White House Office of the National Security Adviser, Box 2, NSC Briefing Notes.

of Defense insisting on the fissile material cutoff as a prerequisite, as well as emphasizing the need for continued testing.[986]

A significant group of reports from the White House Office of the Special Assistant National Security Advisor generated at an August 1958 meeting with the president describe an effort to conclude a mutually agreed test moratorium beginning on 1 October 1958.[987] The parties were unable to agree to end testing that soon, although British atmospheric testing ended with GRAPPLE Z (1 kiloton, 23 September 1958) in apparent attention to the original agreed effective date for test cessation of 1 October. The first fallout era finally closed in early November as the other parties, the United States and the Soviet Union, excused themselves to the negotiations in Geneva after wrapping up their respective final binges of atmospheric testing.

Meanwhile, the Joint Chiefs remained insistent on a fissile material cutoff agreement as a requirement for their support of any test ban agreement. This was a useful, substantive goal, but also seemingly quite superfluous, as MUSIC delivered this information to the JCS in great detail. On the other hand, treating such an initiative as a goal while insisting the Russians self-report their plutonium-239 production suggested the gambit was essentially an effort to compare that declaration with AFOAT-1's documentation of Russian production through its krypton-85 monitoring program.[988] I.I. Rabi's assertion that a test ban would preserve an American technological lead in weapon design was remarked upon by several observers, including statements found among Killian's papers.[989] But the crucial fact that the Pentagon had no real need for such a report went unnoticed in the extant archival record, even though it became clear they were in possession of essentially the same information with MUSIC they hoped to gain via such a disclosure by the Soviet Union. Discrepancies between Russian declarations and

---

[986] General N.F. Twining, "Memorandum for the Secretary of Defense, Subject: Nuclear Testing," 15 August 1958, Ike, Ann Whitman File, Administrative File, Box 25.
[987] U.S. Position on Proposed Revision of First Phase Disarmament," 18 August 1958, Eisenhower Library, White House Office of the National Security Adviser, Box 3.
[988] N.F. Twining, Chair Joint Chiefs of Staff, "Memorandum for the Secretary of Defense: Nuclear Testing," Eisenhower Library, Ann Whitman File, Administrative, Box 25. Twining's memo was undoubtedly shaped by a determination to use AFOAT-1's krypton-85 technique to assess the state of Soviet fissile material production. In 1958, as with the United States, civilian power production was an experimental niche, so their limited production of krypton-85 could be accounted for as it would have to be as future civilian reactors came online. The JCS wanted a sharp cut-off, because the only way to confirm it, given there was no way to differentiate its production for military proposes versus peaceful ones, would be to account for any future civilian production amid a total shutdown of military production of plutonium-239.
[989] A.J. Goodpaster, "Memorandum of Conference with the President," 18 August 1958, Eisenhower Library, Atomic Energy Commission, Vol. II (4),

American and British estimates of Soviet fissile material could serve as a pretext for contention if at substantial variance once the treaty was in effect.

Essentially, the Pentagon sought to hold up an agreement until it reflected revisions that would provide AFOAT-1 with continued access to the best information on Soviet weapons available in lieu of the unit's then-current emphasis on capturing fallout samples. It was only one among a number of objections filed to counter Rabi's position a test ban was a net advantage to the West.[990] Not the first or last of many prerequisites the Pentagon imposed to gain its cooperation, it was but one salient example of how closely vetted such agreements were prior to submission to the Senate for ratification. It was also important to note, given this explicit connection was likewise not reflected in these documents, that the Soviet plutonium-239 stockpile was about 3,681 kilograms in 1958 compared to the United States stockpile of 13,150 kilograms.[991] Clearly, a fissile material cut-off would leave the United States with an enormous advantage, one that far exceeded any potential unmatched technical lead in weapon design that might be discovered by the Russians. The fact that this went unmentioned suggested two possibilities. One was that the classification of the linkage between AFOAT-1's capabilities and the positions Defense and the White House took on diplomacy remains sensitive and thus is still classified. Alternatively, given comments from observers that AFOAT-1/AFTAC never gave up anything without being asked specifically for it even to those with the proper clearances, it was possible the Air Force chose to play these cards very close to its chest.[992] The White House and State may not have realized the stark advantage of the American stockpile lead over Soviet holdings because it did not specifically ask about it in briefings by the military or DOD.

While considerable pro forma political grandstanding over the viability and verifiability of arms control agreements remains typical of Senate review of arms control agreements, assessment of AFTAC's capabilities in connection with American diplomatic initiatives that yielded the resulting 1963 Limited Test Ban Treaty suggested the agreement was well within the capabilities of existing means of verification.[993] American capacity to verify subsequent arms

---

[990] "Critical Weapons Developments to be Lost or Seriously Compromised If the U.S. Ceases Testing," undated response to 7 August 1958 memo (written in the week after that memo, based on a contextual reading), Eisenhower Library, White House Office of the Special National Security Adviser, NSC Briefing Notes, Box 2. Somewhat anti-prophetically, the memo listed the number one unmet priority as "A truly satisfactory Anti-ICBM warhead," a goal which remains unmet decades and billions of dollars later.
[991] See Appendix B.
[992] See Chapter 4, 446-447.
[993] "Trust, but verify," a theme echoed famously by Ronald Reagan, essentially sums up an implicit standard.

control agreements appears to reflect a history of relative certainty in both the intelligence aspects and the necessary verification capabilities by the time they surface for Congressional review, a frame decidedly at odds with the Murphy/Walkowicz trope that U.S. nuclear weapon and intelligence efforts more often than not failed to deliver during the Cold War, a persistent theme of many critics of American foreign policy.[994] Strikingly, the recurring accusatory back-and-forth in the Senate about the constraints and limits of arms control effectiveness, which during the Cold War were dictated as much by what the Pentagon and its supporters in Congress found acceptable as what Moscow did, remains a model called upon to serve domestic and partisan interests as much as it aspires to serve the national interest.[995] The two-decade long failure to so far ratify the 1995 Comprehensive Test Ban Treaty was probably the most important among several recent initiatives where the national interest has been sacrificed to political chicanery that festers in the general ignorance about the history of the extraordinary verification capabilities that support arms control diplomacy.

1959: Senator Gore's Problematic, But Eventually Useful Proposal

Political pressures catalyzed by fallout mounted. A 13 January 1959 memo to Eisenhower from Gordon Gray, Special Assistant to the president, described a proposal from Senator Albert Gore Sr.[996] The senator wanted the Geneva talks to focus on ending fallout by

[994] McMillan, *The Ruin of J. Robert Oppenheimer*, 160-165. Charles J.V. Murphy was an Air Force Reserve officer who wrote the anonymous May 1953 *Fortune* magazine article, "The Hidden Struggle for the H-Bomb," that attacked Oppenheimer over his supposed obstruction of the hydrogen bomb effort. Murphy was aided by Teddy Walkowicz, who was the military aide to David Griggs. Both were intimately involved in the orchestrated media and gossip campaign led by Air Force Secretary Thomas Finletter and General Hoyt Vandenberg and aided by General Jimmy Doolittle that led to the AEC hearing that stripped Oppenheimer of his security clearance.

[995] Air Force Outstanding Unit Award, http://www.afpc.af.mil/library/factsheets/factsheet.asp?id=7785. While the legislative branch harbored doubts about what little it did know about the intelligence and verification capabilities of the AEDS, the executive branch has repeatedly recognized AFOAT-1/AFTAC as among the best of the best. The 1009th Special Weapons Squadron was among the first units awarded the Outstanding Unit Award (OUA) after it first came into use in 1954. The OAU was the first unit award created by the Air Force after its independence from the Army. AFOAT-1 received another OUA for operations in the fall of 1958. Successor units received the OUA eight more times between 1961 and 1982. The OUA "is awarded by the secretary of the Air Force to numbered units that have distinguished themselves by exceptionally meritorious service or outstanding achievement that clearly sets the unit above and apart from similar units. The services include; performance of exceptionally meritorious service, accomplishment of a specific outstanding achievement of national or international significance, combat operations against an armed enemy of the United States, or military operations involving conflict with or exposure to hostile actions by an opposing foreign force."

[996] Gray was one and the same as chair of the panel that permanently suspended Oppenheimer's clearance after serving as the first director of the Psychological Strategy Board, then returned to his post as president of the University of North Carolina. In the interim, he again briefly served as president of the University of North Carolina, then returned to government service as director of the Office of Defense Mobilization, then was appointed as Eisenhower's final National Security Adviser from 1958-1961. Gray's involvement in this narrative is a salient example of where future researchers might usefully reexamine the archive to further unravel the fallout narrative.

ending atmospheric testing if the current talks on a broad arms control and disarmament framework headed towards impasse. While Gray's assessment of consensus from within the White House was the talks were not at that point, they also embraced the idea as consistent with the president's August 1958 policy change delinking a nuclear arms control agreement from a general disarmament pact. The problem was Gore's publicly floating the proposal, which could undermine its potential use as a unilateral "fallback" position should the talks fall apart.

> Such self-imposed moderation may be prudent because, even if the blame for the break in negotiations lies with the Soviet Union, increased pressure of public opinion for a cessation of tests can be expected to be directed against the U.S. and the USSR.[997]

Having noted how transnational pressures fell equally on both the US and USSR because of fallout, the memo suggested reserving any comments or action on Gore's proposal until the negotiations warranted playing this card. Eisenhower still wanted a total test ban, even after decoupling the test ban discussion from the previous linkage of it to an overall disarmament agreement in order to more expeditiously address the problems fallout created.

Teller Adopts Low-Yield Strategy

Gordon Gray's January 1959 day was very busy, as the same day he also forwarded to the president's military aide, General Andrew Goodpaster, a transcript of a talk given by Edward Teller on 20 November 1958 at the National War College.[998] Classified Secret, the report reflected Teller's belated, ironically implicit embrace of the Oppenheimer tactical weapons initiative, a transformation conducted behind closed curtains.[999] While not renouncing his passion for high-yield weapons – "…I don't want to eliminate big weapons from limited nuclear war…" – so much as embracing a trend toward what he argued were more practical weapons – "as you will see, use of nuclear weapons in limited warfare is to our advantage" –Teller's shifting strategic enthusiasms represented a telling turnabout caused in large part by fallout's cumulative threat, which made general nuclear war fought with high-yield weapons strategically

---

[997] Gordon Gray, "Memorandum for the President, Subject: Conference on Discontinuance of Nuclear Testing," 13 January 1959, Eisenhower Library, White House Office of the Special Assistant for National Security, NSC Briefing Notes, Box 3.

[998] While there was no response to the Teller speech associated with the transcript, Goodpaster apparently drew some conclusions about such enthusiasms as Teller's. Commenting in 1994, the retired general observed, "Increasingly, nuclear weapons are seen to constitute a nuisance and a danger rather than a benefit or a source of strength." http://gsinstitute.org/dpe/quotes.html.

[999] Hansen, *Swords of Armageddon*, VI-54-61, 512-519. Interestingly, Teller's enthusiasm for low yield weapons was the end result of a process that began about the time Oppenheimer was finally walled-off from secrets by order of the president in December 1953.

infeasible as a concept. The Hungarian-American physicist embraced the concept of limited nuclear war fought with low-yield weapons, in conflicts such as those "in Hungary and in Algeria," arguing that change in the strategic situation versus the Russians over the last decade made this policy necessary, without explaining why things changed beyond the initial loss of the American nuclear monopoly in 1949. Teller argued the United States faced the "danger of being put into a position where the possibility of any kind of limited war will vanish." As General Power did a year later, Teller insisted "the danger is the cessation of nuclear testing," given the need he saw to develop low-yield weapons to fight such limited wars.[1000]

The need to continue testing to meet this research and development requirement for low-yield weapons in turn paralleled the need to monitor the Soviet Union for similar efforts. Teller directly linked the controversy over the disputed viability of the lowest threshold of detection the proposed Geneva system of seismic monitoring was capable of and the fact this area of very low-yield devices was exactly what was of most interest as fallout forced nuclear testing to turn in this direction and quite possibly go undetected. Teller furthermore alleged that, while Soviet institutions would have no trouble cheating at the low yield levels he claimed were undetectable, Americans were culturally too honest to support such subterfuge if the United States were party to a binding agreement prohibiting all testing. Teller argued this meant any agreement would turn into a decisive Russian advantage as they cheated and the West did not.[1001]

Speaking within three weeks of the temporary test moratorium going into effect, Teller used the occasion to rally the troops around the need for a quick resumption of testing with promises of continuing development of a family of highly portable nuclear artillery. Teller enthused over a newly tested design for ground troops, the Davy Crockett short-range battlefield mortar, describing the way its portability would transform land warfare by sharply limiting the logistical requirements commanders faced when employing conventional weapons. Along with the Davy Crockett, Teller envisioned a family of weapons similar to it, but with longer range and

[1000] Edward Teller, "The Impact of Nuclear Energy on Military Power," Secret, Speech delivered at the National War College, Washington, EC, 20 November 1958.
[1001] Hans Bethe, "Memorandum for Dr. Killian: Impressions on the Geneva Discussions," 14 August 1958, Eisenhower Library, White House Office of the Special National Security Adviser, NSC Briefing Notes, Box 13. Teller and Rand Corporation's Albert Latter proposed a theory of decoupling, a method to significantly dampen the seismic signal generated by a nuclear explosion by undertaking it with the device suspended in a massive underground chamber. They believed the Soviets could use this method to evade test ban treaty limitations. Always a rather impractical scheme, in a memo to James Killian Hans Bethe noted, "Concealment of underground tests, by deliberate reduction of coupling, has become very doubtful."

a selection of yields, all miniaturized to equip a specialized cadre of skilled nuclear- capable troops forming the core of future Army and Marine Corps combat formations. Teller implicitly argued these new weapons should be considered as conventional in nature through his choice of discourse, calling them "nuclear explosives," and hardly mentioning the singular limiting factor in their use, the threat of their cumulative and local fallout even if nuclear war could be fought on a limited basis with them without escalation to general war.

The Davy Crockett or W-54 warhead was one of the first post-Oppenheimer era tactical weapon designs. It sprang from a program initiated in early 1958 but was part of a class of weapons only made possible in a timely fashion by dint of the 1950 GAC's sticking to its guns in pursuing tactical weapon designs at a time when the Air Force – and Teller – wanted only high-yield weapons. The Pentagon showed a distinct lack of interest in such low-yield designs when first proposed in 1952, but by 1958 the need to limit fallout exposures was among the motivations behind the Army seeking such a low yield weapon. The W-54 physics package underwent a series of tests at HARDTACK I and II in 1958, leading to weapon production and stockpiling beginning in 1961. The weapon was tested underground in Operation NOUGAT when the temporary test moratorium ended in fall1961, then was tested twice as part of the final series of atmospheric test in Nevada in 1962. This included the last of all atmospheric tests at NTS, a field demonstration of the Davy Crockett, with notable guests including Attorney General Robert Kennedy and General Maxwell Taylor.[1002]

The irony of Teller's effort to find a weapon useful on the battle field was Eisenhower had already been there, done that by the time Teller found himself singing the praises of low yield tactical nuclear weaponry in late 1958. The atomic battlefield Teller anticipated was already obsolete in the president's eyes, indiscernibly different from the president's own myopic New Look when it came to fallout.

[1002] Hansen, *Swords of Armageddon*, VI-54-61, 512-519. The original design languished in the atmosphere surrounding the Oppenheimer affair, even after the concept received Teller's endorsement in 1953. It was General LeMay who revived the project when, on finding himself as Air Vice Chief of Staff in late 1957, reached for the all-around solution to defense against nuclear attack, a nuclear air defense weapon. Unlike the unguided Genie rocket that was tested overhead at NTS that year, this weapon would ride a guided missile to its target. The same warhead design used by the Air Force was then used for the Army's DAVY CROCKETT physics package. Designated originally as the XW-51, it was re-categorized as the XW-54 in early 1959 as the design was undergoing standardization. Taylor served as Army Chief of Staff under Eisenhower, but resigned in 1959 as a critic of Eisenhower's nuclear policies. Rehabilitated as a military adviser by John F. Kennedy, Taylor was later appointed Chair of the Joint Chiefs of Staff in a most unorthodox detour on the typical path taken to that position.

Chapter Five: Testing, the Limits of Fallout

When historians use example, citation, and argument to explain and interpret the meaning of the past, it can be tempting for critics to declare that the resulting narrative comprises a selective, peculiaristic choice to fit a preconceived and largely invented opinion about the past. Setting the vagaries of individual subjectivity aside, the opportunity provided by stumbling across a quotable source from the era that rather compactly sums up a substantial part of a historian's argument about it is always valued as a strong piece of evidence to bolster what might seem an esoteric point or two. All the more so when this labor must overcome what frequently remains a deliberately obscured record. Finding a source that speaks directly to a project's primary premise readily available in compact form can fundamentally validate an argument forced to rely in part on some considered assumptions. While unsigned, the unamed author of the following reflection from 1959 represented at least a substantive body of belief about fallout among the officers and readers of *Air Force*, the Air Force Association's monthly magazine.

> When the U.S. tested its first H-device, the amount of radioactivity released turned out to be considerably larger than had been anticipated.[1003] The hydrogen weapon had been developed primarily to achieve maximum blast and heat effects. When it appeared that radioactivity was among the primary effects of H-weapons, the inclination was to use "fallout" as a bonus…
>
> Radioactivity, therefore, was the factor which made of the hydrogen bomb the first true area weapon of history…
>
> Subsequently, it became apparent that this very effectiveness…tends to make the weapon quite unmanageable and may prevent its utilization…
>
> Widespread, heavy fallout…would probably also "backfire" against friendly nations and cause heavy casualties among the very peoples, including one's own, whom the military operations were designed to protect.
>
> Fallout may actually preclude success in war.
>
> The most basic objection to uncontrolled fallout, in fact, is that it would tend to render war unmanageable as a rational tool of policy and national security.[1004]

[1003] This premise was both clearly untrue and conflated the results of IVY MIKE (10 megatons, 1 November 1952) and CASTLE BRAVO (15 megatons, 1 March 1954). Even before IVY MIKE, the government knew massive fallout would be one result. It was a statement that concealed the fact that Robert Oppenheimer paid with his career in attempting to remind SAC fallout would have to be taken into consideration in war planning.

[1004] "The Clean Weapons Problem," *Air Force*, Vol. 42, No. 12 (December 1959), 36-37.

The evidence was clear that fallout would have given Dwight Eisenhower and John F. Kennedy plenty to think about if they ever found themselves in position of having mere minutes to consider unleashing "the great atomic power."[1005] Every United States president since, as well as Soviet and Russian leaders and those of the other nuclear arms possessing nations, has faced and will face the same pushback from fallout should such a situation arise.

Anonymously authored, the best the *Air Force* magazine article could offer in December 1959 was clearly a tested and failed solution. Developing a "clean weapons…capability as soon as possible" was already dismissed by the Pentagon's leadership as pointless.[1006] The general public did not know that dead-end had already been reached, even as Air Force boosters sought to whip up support for this illusory distraction as part of their argument for resumption of testing. While war plans included some qualitatively "clean" weapons, the quantity still totaled up to a dirty result that could not simply be washed out as detergent advertising insisted. Change, even when starkly necessary, came slowly. With the fallout stopped, opportunity for diplomacy expanded, only to be cut-short by crisis after crisis and contaminated by the worst year for fallout ever, 1962. Remarkably, desire to end fallout proved stronger than the lure of conflict.

Tipping Point

The years 1955 to 1958 represented an approach to a tipping point, a liminal interlude of transition between fallout as a vital secret enmeshed in the problematic glare of public attention amid a broadening nuclear intelligence program and Eisenhower's conclusive recognition that fallout would remain a fundamental constraint on the military utility of nuclear weapons. Beyond advances in detection of nuclear explosions, hard won technical knowledge led to improved global networks to collect and process data on fissile material and weapon production and stockpiling, in the process shaping the basis for the technical support systems nuclear arms control pacts depend upon for verification. Testing during this three-year period produced more fallout than the total from all previous testing since 1945.[1007] As fallout contaminated the entire

[1005] The Louvin Brothers, "Great Atomic Power," (Ira Louvin-Charles Louvin-Buddy Bain), 1952, MGM 11 277.
[1006] "The Clean Weapons Problem," *Air Force*, Vol. 42, No. 12 (December 1959), 38. Unattributed or anonymous authorship of articles in publications of advocacy organizations frequently reflects the official stance of the organization itself.
[1007] Data on this page is primarily derived from Federal Radiation Council, *Estimates and Reevaluation of Fallout in the United States from Nuclear Weapons Testing* (Washington, DC: U.S.G.P.O., May 1963). Additional narrative and data on test yields can be found in Appendix D. Totals do not match, given the different data sets available when created, yet there are no gross disagreements.

planet, both military personnel and academic sectors found increasingly sophisticated capabilities to detect and measure it in their hands.[1008]

New fallout suddenly ceased at the end of 1958 as the United Kingdom, United States and the Union of Soviet Socialist Republics agreed to voluntarily suspend testing, take stock and pursue agreement on a permanent test ban. Despite the substantial increase in testing after 1955, through to the beginning of what turned out to be a temporary moratorium on all testing at the end of 1958 only about one-third of the total fallout generated during the Cold War had been created, with the first three nuclear powers conducting some 300 tests totaling roughly 174 megatons of fission and fusion yield over the thirteen years since TRINITY in 1945.[1009]

After taking a break from testing in 1959 and 1960, Soviet Premier Nikita Khrushchev resumed testing in a challenge to crisis-burdened President John F. Kennedy after he assumed office in 1961. The United States undertook a number of underground tests late that year in response, trying to draw a favorable comparison between those shots and the dirty and quite profligate Soviet atmospheric test series underway before the U.S. decided it, too, would join in. During 1962, the Americans dirtied the atmosphere again, but limited further atmospheric testing to 38 megatons of yield jam-packed with every possible device ready for the testing grounds. The Soviet Union, clearly making a point they could contaminate the environment just as handily as the Americans, over just fifteen months detonated an astonishing 220 megatons of weapons aboveground, a total that in itself exceeded all previous fallout produced, as well as concentrating 89% of total Soviet fallout yield into just one year, 1962. The 1962 Soviet test series alone represented some 42% of all fallout produced by atmospheric testing. Combined with U.S. fallout that year, the 1962 total of 258 megatons of yield tested in one year was roughly half of all fallout produced during the Cold War; two-thirds of all fallout produced was in 1961-1962. The Soviet Union surpassed the American atmospheric test total of 141 megatons

[1008] Fallout was concentrated in the Northern Hemisphere. Documentation of fallout's circulation helped establish that global scale atmospheric circulation patterns tend to confine air masses north and south of the equator to their respective hemispheres due to the limited inter-hemispheric mixing of the atmosphere. Since the vast majority of all testing occurred north of the equator, most of the fallout stayed there, rendering the scenario in the hallmark 1957 novel, *On the Beach*, of fallout advancing south to Australia largely fictitious.

[1009] Federal Radiation Council, *Estimates and Reevaluation of Fallout*, 4. The United States detonated nearly 200 shots through 1958, the USSR about 85, and the British more than a dozen. About one megacurie of strontium-90 is produced from 10 megatons of fission yield. The object of Willard Libby's Project Sunshine research, strontium-90 was a significant portion of fallout, but it was but one among dozens of isotopes present after a nuclear explosion, so strontium-90 data only begins to describe the scope of fallout's potential health and environmental problems.

by more than 100 megatons for a total of 247 megatons after trailing the United States total until its final fallout binge of 1962.[1010]

Closely monitored by the AFTAC-mission dedicated U-2 fleet, the massive injection of radioactive isotopes was the closest the world has yet come to encountering contamination from an actual nuclear war. Roughly four times as large as 60 megaton warning line originally suggested by GABRIEL that was reached over the course of nine years at roughly the conclusion of the CASTLE test series in 1954, samples from 1962 and 1963 offered a fourth, quite distinctive group of data to compare with that collected prior to July 1945, from then until the end of 1958, and for the period when the air began to clear from 1958 to 1961 during the temporary test moratorium. When and if released, analysis of this historic data will provide the best evidence available about the movement of fallout in the atmosphere and, after its return to the ground-level environment, its deposition and circulation in the biosphere.

The narrative here goes in several directions, but connecting some of the essential dots for readers will aid in its digestibility. In a sense, this was because fallout acts as a universal contaminant insinuated into Cold War history as thoroughly as it spread into the global ecosystem and atmosphere. As with its role as an unseen yet intimately physical threat, once the proper instruments for detecting its meaning and role in the social order are at hand, fallout's end game plays out in view. Kennedy's presidency, begun with the fallout genie back in the bottle but with the diplomatic process congealed by the effects of Eisenhower's authorization of one too many U-2 flights, demonstrated the two presidents largely hewed to a policy of continuity regarding fallout; this suggested the need to address fallout was a data-driven policy, rather than one driven by ideology, partisanship, or emotion. Considering the intervening multiple, nuclear-enhanced crises and the AEC's habit of engaging in wishful public statements, rather than factual thinking about fallout prior to 1963, it was an even more remarkable achievement.

When the 1958 test moratorium went into effect, fallout represented an unusual policy continuity between East and West, opening lines of communication that eventually put the first three nuclear powers all on the same page of agreement to end fallout, despite their multiple other differences. These factors also suggest fallout's end was due to something more than an era of good feeling breaking out, which was certainly not the case, or solely the result of public

[1010] "Known Nuclear Tests Worldwide, 1945-1995," *Bulletin of the Atomic Scientists,* Vol. 52, No. 3 (May/June 1996), 61-63.

pressures to end testing, which had relatively little effect on the Soviet Union. Implicit in the end of fallout from testing was recognition that the voluminous cumulative threat posed by wartime fallout largely undermined any practical rationale for the use of nuclear weapons, a stark fact that began to be recognized, as in this chapter's opening vignette, act as a limit in the arms race .

While political pressures mounted in public, behind the scenes a body of evidence was growing that suggested fallout need be taken far more seriously than many in the Eisenhower administration believed necessary in their prior public representations. At the same time, long-unquestioned past assumptions derived from data produced by AFOAT-1/AFTAC on the Soviet stockpile that Air Force analysts used as the primary basis for the much-hypothesized, yet non-existent bomber and missile gaps came under scrutiny. U-2 imagery pointed out significant issues with the accuracy of national intelligence estimates of the capabilities of Russian nuclear forces based on stockpile estimates.

The success of the CIA's U-2, which for the first time provided SAC's bomber force with truly accurate information for many of its targets, was part of the process opening the door to the many advantages of satellites; here, too, fallout was deeply embedded within a familiar Cold War canon. Something as simple as knowing exactly where your target was lessened the need for excess megatons of unnecessarily destructive fallout yield previously required to provide the certainty of destruction needed to satisfy SAC's target planners. Ironically, at the same time CIA U-2 imagery brought into question the accuracy of some of the unit's previous work, in the hands of the Air Force the aircraft also opened the door to the stratosphere for AFOAT-1 – and to researchers seeking to finally determine where all the fallout went and for how long. The answers to these questions eventually supported an end to fallout. Nuclear intelligence would remain important, but the quick pace and robust expansion of Soviet nuclear power meant that the weapons grew relatively less important compared to the need to better understand their delivery systems. Overhead imaging and its capacity to supply contextual, often compelling insights into Soviet intent and capabilities began to eclipse the need for much of the accurate, but far more narrowly focused results obtained by AFTAC from what seemed to be thin air. AFTAC was born in 1959 from AFOAT-1 into a transformative process where fallout grew relatively less important as imagery became the best means to monitor the global threat environment as part of a diverse and comprehensive suite of intelligence resources and – with the signing of the 1963 Limited Test Ban Treaty – arms control agreement verification capabilities.

Wheat and Milk

While part of fallout's end game focuses on the policy perils of powerful politicians with the advanced technology of vast networks of military power at their fingertips, important roles remained for the humblest items of everyday consumption and the consumers who used them. Both Eisenhower and Kennedy publicly acted on fallout after newfound capacity for detecting fallout in the food supply brought about scares over wheat (1959) and milk (1962) respectively. While the circumstances of both events – somewhat controversially – suggested the need for immediate action to protect public health from ever more ubiquitous fallout, the facts are indisputable that the policy decisions made reflected the public evolution of a secret policy determination to end fallout. These decisions were based on quantifiable, empirical data that described fallout's spread from the ecosystem into the food chain and elsewhere in the environment. Thus, this narrative casts a light on a dramatic, secret about-face on fallout by the atomic Air Force. The exact reason for this policy change remains unclear beyond that it was science-based and data-driven. The Air Force's leadership, similar to how they were willing to bring up the intelligence aspects of fallout at the 1954 Oppenheimer hearing in order to preserve the discussion from veering toward fallout's limits on nuclear war, apparently recognized the fallout that facilitated its rapid growth during the nineteen-fifties nonetheless forced it to shift to support restricting nuclear testing to underground locations in order to once again avoid a pointed discussion about the practicality of the very concept of nuclear war. Less than two decades after the first small increment of fallout went into the atmosphere at TRINITY and just fourteen years after the Soviet Union broke the American nuclear monopoly with its own first test, for the most part fallout was retired with the Limited Test Ban Treaty of 1963.[1011]

AFOAT-1 Looks beyond Fallout

After a decade of research, development, and operational refinement, 1958 marked the completion of the build out of the AEDS so that it was truly a network with global coverage, going beyond fallout in order to detect nuclear tests reliably by multiple means. This achievement was first partially met beginning in 1949, when the focus was solely on the Soviet Union. A view of this transformation was provided by an anonymous informant who served with

[1011] The United States, the USSR, and the British ceased all atmospheric testing with their ratification of the 1963 LTBT. The French and Chinese continued the practice for several more decades before ceasing atmospheric tests, but on a far more limited scale. Other nuclear nations routinely now always test underground, both because they desire to limit the data they provide foreign intelligence services and because of the universal "nuclear taboo" engendered by reaction to fallout.

AFOAT-1 beginning in the mid-1950s. He described how the primitive second generation EMP detection system known as the Q2, composed of a limited network of four stations, three in the United States and a fourth in Lahore, Pakistan, was significantly upgraded. The Q2 could confirm the direction of the signal source and detonation time, but was not capable of recording the waveform for further analysis. The Q2 system was replaced in 1957 and 1958 with the Q3 system, capable of recording the signal, but improved to operate on three different frequencies. Roughly a dozen stations were then involved, providing far more useful data, significantly more accurate direction-finding, and coverage that extended globally.[1012] Plenty of work for Air Force Technical Applications Center (AFTAC) remained ahead, as AFOAT-1 became known in the summer of 1959, as well as for Eisenhower's team at the White House, negotiators in Geneva, and activists in the streets as fallout fell from the sky, but which for the moment saw no further contributions from testing in the atmosphere.

Nuclear Scarcity Banished, Global Environment Threatened

By 1958, British interest in MUSIC waned.[1013] For the British, once the joint U.S./U.K. effort to define Soviet plutonium production through sampling krypton-85 determined the threat was extensive, with a stockpile deep enough to sustain a war against the West and prevail under favorable circumstances, there was little to be gained by understanding what level of overkill existed beyond catastrophic. The krypton-85 data AFTAC continued to produce remained an essential part of the Air Force arsenal of justification for its annual budget; the Soviet threat it defined inspired Congressional willingness to fund SAC bombers and missiles. While the limited data set provided by rough comparisons of fissile material and weapons production in the appendices is only representative and suggestive, such force-to-force comparisons nonetheless represented substantial insight of the most extraordinary sensitivity, both militarily and

[1012] Anonymous, 5-page manuscript in author's files, informant gave permission to use it, but requested his identity be kept confidential.

[1013] Goodman, *Spying on the Nuclear Bear*, 185, 198. Due to the limits of space, discussion of Britain's role in monitoring Soviet fissile material production will largely go by the wayside. For both financial and diplomatic reasons, the formal MUSIC krypton-85 monitoring program was stood down, although parts of it continued elsewhere in the British nuclear program. The British also remained informed on the matter in liaison with their American counterparts in accord with past practice, but no longer took a direct role in producing the requisite reports providing the analytical sampling and analysis. While AFTAC continued to do sampling and analysis, unlike the British, the fact that the method was ancillary to the basic aerospace utility of liquid oxygen production the Air Force conducted for its global operations made it relatively easier to support on a continuing basis.

politically.[1014] Most force comparisons count airframes, but counting what weapons were available to deliver was also important, just not as all important as was long argued by the Air Force. What was erroneous about the "gaps" was how Air Force analysts relied on krypton-85 numbers as definitive. Imagery problematized these oversimplifications.

What do the data on fissile material production show from 1959 onward through ratification of the 1963 Limited Test Ban Treaty? What did the strategic significance of such comparisons mean at the time to those with clearance to read them? How did fallout play a role in informing and interpreting this data for policy makers? Significant growth in their respective cumulative plutonium stockpiles, the representative but not conclusive yardstick used here to illustrate the relative strength of American and Soviet nuclear forces during the early Cold War, was a basic fact known to be available to key policy makers; despite growing British disinterest, American efforts to track the Soviet stockpile continued apace in the second decade of nuclear weapons and fallout from 1956 to 1965. Investments in expanded production paid off in large yearly increases in fissile material production, sustaining the rapid deployment of new weapon designs.[1015] The increases in yearly production were significant, but told only part of the story. What counted most of all was the cumulative total fallout potential from their anticipated use in war. The simple fact that the total megatonnage available to both East and West quickly made war itself an untenable instrument of national policy in the 1950s can be inferred from the rough estimates provided in Appendix B.

AFOAT-1's basic work of tracking fallout in the troposphere for intelligence purposes was substantially augmented by the U-2 aircraft's stratospheric sampling after 1957. The impact of the test moratorium and discovery of the subsequent relatively quick return rate of much of the fallout through sampling-oriented surveillance and collection programs provided a relatively concrete evaluation of yield versus fallout deposition on the order theorized as problematic by GABRIEL. The main difference was its deposition was spread over a considerably longer time frame than fallout from a nuclear war. While less intense than if due to a war, fallout generated from testing through the 1958 series nonetheless was on a scale that provided a rough baseline

[1014] Appendix B presents such a rough comparison. While not an official document, it represents a summary of information that was available to key policy makers with the requisite clearances. These tables accurately show general trends in fissile material stocks, weapons inventory, and the potential for significant fallout yield if war dumped fallout into the atmosphere.

[1015] Compare levels in Appendix B on early Cold War fissile material production and estimated warhead production.

for exposures comparable to the yield assumptions GABRIEL outlined under early nuclear war scenarios.[1016]

The ad hoc, non-binding test moratorium John F. Kennedy inherited from Eisenhower lasted a total of two years and ten months before the Soviet Union reinitiated atmospheric testing in September 1961. This provided ample opportunity to document a sample group demonstrating the decay of fallout as the atmosphere cleansed itself. However, it also confirmed the worrisome finding that residence time for stratospheric fallout was far shorter than earlier theorized, thus intensifying the threat fallout posed to recovery from nuclear war and the period of sheltering and other protective measures required in such a war's aftermath. While ending fallout was not the only reason for the often fragile support the Joint Chiefs gave to arms control, whatever basis, political or empirical, supported their acquiescence to ending all but underground testing was accompanied by the crumbling of Willard Libby's embrace of the theory of stratospheric residence that was previously believed to limit massive post-attack fallout.[1017] The situation that forced the Joint Chiefs' hand in 1958 to accept the concession of ending atmospheric testing eventually proved even grimmer. In itself, the immediate threat of post-attack prompt fallout near to and downwind from targeted areas by the early 1960s led to general recommendations from civil defense officials that Americans prepare for two-week long shelter stays. Little was said about the much longer post-attack period after the acute threat of fallout requiring full-time sheltering passed, in large part because doing so would require reference to this sensitive information, as well as navigating obvious political sensitivities about the post-attack environment the government showed little interest in confronting.

[1016] As with evaluation of the health risks fallout may present, the project takes no definitive position on the outcome of such a war. A thorough evaluation of such estimates and the evidence that supported conclusions drawn from them represent a significant project in itself, requiring specialized expertise in the field of radiation safety. Such a project also presumes access to the data the Air Force continues to withhold. What can be said about the concrete conclusions drawn at the time was that nearly all signs pointed in the direction of ending fallout.

[1017] Hewlett and Holl, *Atoms for Peace and War*, 328-331. Libby made the first public presentation of data derived from Sunshine in January 1956 and published it as part of the AEC annual report to Congress in December 1955. Libby's argument was that the buffer provided by the stratosphere accounted for the missing fallout from thermonuclear testing, as well as limiting the impact of such fallout by stretching its return to the surface environment. Given Libby's previous work consulting with AFOAT-1, the obvious connections of the research to intelligence requirements, and the secrecy very much like that in which fallout was cloaked at the Oppenheimer hearing after Sunshine began, as with the krypton-85 technique, Libby's strontium-90 project likely had its genesis in a requirement generated by AFOAT-1.

Atmospheric Buffering Revisited

The Air Force's low-key, yet fundamental shift on the matter of fallout strongly suggested it was driven by the failure of a theory that Willard Libby promoted suggesting a prolonged stratospheric residence time would keep the most dangerous fallout aloft to safely decay; instead, the atmosphere turned out to offer little protection or delay in fallout's return to the earth's surface. [1018] "Clean" weapons designs represented a fruitless and frustrating quest for fallout-free nuclear weapons. Substantial reductions in fallout relative to yield were possible, but war plans anticipating use of thousands of weapons still produced massive cumulative fallout totals. A little over a decade after the youngest military service fully embraced nuclear weapons, fallout cast a mordant pall over the prospects of relying on these weapons that inevitably produced it as a useful way to project military power. While there was grumbling from the rank-and-file, crowned by SAC Commander General Thomas Power's emotional plea to the JCS to put the American people on notice about how badly they needed fallout, the relative silence on the matter from Curtis LeMay and others at headquarters spoke to the fact that they grudgingly accepted fallout was a graver potential threat to their flexibility to respond militarily.[1019] Continuing to test in the atmosphere would mean a never ending increase in public attention to nuclear weapons themselves, a prospect that was poised to limit military prerogatives far more than doing without fallout from testing might. Reinforcing such protests would be samples collected and analyzed independently of the government. With certain brief exceptions since,

---

[1018] "Classified Discussions at Harwell by L.T. Alexander and R.A. Dudley." [undated, but context places it in 1955 for reporting on visit between 31 January and 3 February 1955], NARA College Park, AEC, Division of Biology and Medicine, Project Sunshine, RG 326.73. Strongly associated with Libby, the theory that fallout which thermonuclear devices drove into the stratosphere would reside there long enough to permit the bulk of it to decay before it eventually returned to lower altitudes originated inside the Atomic Energy Research Establishment at Harwell. Headed by Sir John Cockcroft, it was the British equivalent to Los Alamos and Hanford at one site called "the Atomic" by locals. Two AEC researchers traveled there on behalf of a revised, revived, and even more secret GABRIEL, ensconced by then within Libby's Project Sunshine. They filed this report describing the potential for the British to help collect baby bone and soil samples. The stratospheric residence theory was of special interest because of the insights it could provide to GABRIEL's predictions of post-attack radiation scenarios.

[1019] "William Kaufmann, 90; MIT political scientist reshaped Kennedy's defense strategy," *The Boston Globe*, 26 December 2008, http://www.boston.com/news/education/higher/articles/2008/12/26/william_kaufmann_90_mit_political_scientist_reshaped_kennedys_defense_strategy/. Power was famous for ordering the directive to move SAC to DEFCON 2 status by broadcasting that order in the clear during the Cuban Missile Crisis, instead of in code. His views on fallout and "winning" a nuclear war differed substantially from his commander-in-chief's, even setting him apart from LeMay's aggressive posture. Responding to a RAND study stressing the benefits of a counter-force strategy, i.e. prioritizing attacks on Soviet strategic forces, rather than ones aimed at cities and industrial centers, Power shot back, "Restraint? Why are you so concerned with saving their lives? The whole idea is to kill the bastards. At the end of the war if there are two Americans and one Russian left alive, we win!"

notably during the Reagan administration, ending fallout served remarkably well in demobilizing popular opposition to nuclear weapons.

1957 and 1958: CROWFLIGHT and Strontium-90's Atmospheric Residence Time

While it was a problem seemingly resistant to the usual experimental methods, assessing the risk posed by wartime fallout was facilitated by the fact that testing produced what was in effect a global experiment facilitated by fallout's contamination of the atmosphere. The general thrust of the earlier Human Effects Panel and the Gaither Committee, discussed in the last chapter in terms of their specific relationship to fallout, were familiar to Cold War historians. Between publication of the Human Effects report and completion of Gaither's work came a more significant signal that the problem of fallout was undergoing a substantial reevaluation. CROWFLIGHT was initiated by issuance of a set of Secret, "need-to-know" only basis orders dated 11 October 1957 to General LeMay's U-2 fleet, flown by the 4080th Strategic Reconnaissance Wing (Light), "to determine the worldwide distribution of particulate and gaseous material in the upper atmosphere from detonations of nuclear weapons."[1020] In this striking way, the Air Force's choice to put the exotic aircraft to work for science in order to better define the threat posed by fallout demonstrated how high the stakes now were over fallout by it being the first major assignment for the SAC U-2 unit. Until the 1963 LTBT was ratified and ended most atmospheric testing, the Laughlin AFB, Texas unit spent a large percentage of its available time and resources acting as a "contractor" for AFOAT-1, bringing back samples from the stratosphere via the reliable and repeatable method of capturing them with particulate and gaseous sampling devices aboard the U-2.[1021] CROWFLIGHT discretely opened the Air Force's closely controlled nuclear intelligence operations to provide a selected set of researchers with stratospheric fallout data to determine where fallout went to reside in order to test Libby's

[1020] 4080th Strategic Reconnaissance Wing (Light), "Operations Order No. 74-57, CROWFLIGHT," 11 October 1957, 4080th SRW 1957 unit history, Air Force Historical Research Agency, Maxwell Air Force Base, Reel# 960. Much of the training during the unit's first full year of operations was apparently for the specific purpose of conducting the CROWFLIGHT mission, which commenced on 1 November.

[1021] AFTAC, *1959 Unit History*, 20-21; AFTAC, *1960 Unit History*, 25-32; AFTAC, *1961 Unit History*, 17-18, 49; John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), 237. ©American Meteorological Society. Used with permission. During roughly the same period as the 4080th was standing up its U-2 fleet for operations, AFOAT-1 again experimented with balloons to capture samples and developed a limited operational capability with four detachments operating the General Mills-supplied stratospheric balloons. The sole advantage over the U-2 proved to be their capability of reaching higher altitudes that otherwise could only be sampled with rockets, which came into use when the Soviets resumed testing in 1961. As with GENETRIX, balloons proved to be unreliable, leading to a contraction to just one detachment in 1959 and eventually limiting their use to monthly baseline sample flights to altitudes of up to 120,000 feet once it became clear the U-2 could accomplish the bulk of the CROWFLIGHT mission.

atmospheric buffering theory that aspired to account for the “missing” fallout. CROWFLIGHT made it possible to extrapolate the data gathered from test fallout to a model of potential wartime fallout. The CROWFLIGHT mission was apparently initiated by a far from mundane “weather report” that arrived to stoke the fires of reconsideration over SAC’s betting the house on massive retaliation with thermonuclear weapons. The result reconfigured national security priorities and policies, shaped by empirical evidence of fallout’s threat to the environment and human health.

Weather Report: Weathering Fallout

What prompted the Air Force’s sudden interest in supporting a better definition of the threat posed by fallout? As the National Security Council’s recognition of the historically far better-documented political pressures mounted over fallout, just days later came some of the first empirically-based indications a greater scientific focus on the general threat posed by fallout was unlikely to provide reassuring news. A 9 April 1957 memorandum from Harry Wexler, chair of the National Academy of Sciences Committee on Meteorological Aspects of the Effects of Atomic Radiation, reminded committee members of an upcoming meeting, while notifying them of an agenda change to discuss significant developing issues. Wexler’s primary concern was prompted by Dr. Lester Machta’s discovery that, instead of adhering to Libby’s theory that fallout dispersed more or less evenly into the environment into lower and lower concentrations as it decayed and was diluted by the atmosphere, recent research on soil and upper air samples indicated unknown processes caused global fallout deposition to occur unevenly. The equator’s boundary effect limited interhemispheric circulation; the vast majority of radiation loosed by testing into the Northern Hemisphere’s atmosphere remained there, instead of dispersing to the south. Even more disturbing was that fallout deposited from the stratosphere concentrated into bands across latitudes bisecting the bulk of the continental United States. The NAS committee Wexler chaired included a number of those whose organizational identification suggested a close association with the Air Force’s nuclear intelligence programs or research and development in support of it.[1022]

[1022] Harry Wexler, letter to Members of the National Academy of Sciences Committee on Meteorological Aspects of the Effects of Atomic Radiation, 9 April 1957, NARA RG 326.73, Project Sunshine, Box 2.These included an Air Force colonel representing the Air Research and Development Command, a scientist from the Air Force’s Cambridge Research Center, and a RAND employee. One committee consultant’s name stood out, Joshua Z. Holland, who worked on the secret 1948 Oak Ridge radiation release as a Weather Bureau representative, but apparently was subsequently hired by the AEC. The letter suggested Holland’s presence was about reactor safety, although a subsequent 9 August letter clearly implicated his role was more complicated than occupational health.

A sudden spate of articles discussing "delayed" or global fallout from injections of it into the stratosphere due to thermonuclear testing that appeared in *Science* during 1957 were also cited as a concern by Wexler.[1023] Instead of again initiating a dismissive public narrative by the AEC, this time suggestive empirical data found its way into the hands of a research group inside the government. The goal of these meteorological scientists in the U.S. Weather Bureau was to understand fallout rather than simply explain it away. To do that required routine access into the stratosphere to collect samples at various altitudes to better define the life cycle of fallout there.

While rockets and balloons held some potential to reach altitudes of 90,000 feet or more, experience at that point suggested a piloted aircraft was required to reliably obtain samples across the wide geographic range required for this research at lower altitudes, but above the performance envelope of conventional aircraft.[1024] Writing in support of funding a reliable means to gather samples from the upper atmosphere, the NAS committee composed a letter that was sent under the signature of Detlev Bronk, NAS president, to the AEC and DOD, arguing the urgent need to fund this research. The draft tiptoed around the sensitive aspects of sampling by referring only to "four balloon sampling stations," describing them vaguely as an AEC program.[1025] Informed by the committee's call for improved capabilities needed to better document the stratospheric circulation of fallout, it implied better means were available but outlined these only to the extent that the "Department of Defense program was not described beyond that which appeared in newspaper reports."[1026] The draft of Bronk's request for an intensified, expanded sampling program presumed the capability existed to meet the requirement

---

[1023] Harry Wexler, letter to Members of the National Academy of Sciences Committee on Meteorological Aspects of the Effects of Atomic Radiation, 27 August 1957, NARA RG 326.73, Project Sunshine, Box 2.

[1024] John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), 234-237. ©American Meteorological Society. Used with permission. The 1212th Balloon Activities Squadron utilized balloons to sample at high altitudes, although it was redesignated the 1110th BAS during or prior to a reorganization that brought all such activities under the management of the Air Weather Service. During 1959, three of the four stations launching balloons (Albrook AFB, Panama Canal Zone, Sao Paulo Brazil, and Sioux City, Iowa) shut down, leaving San Angelo, Texas as the remaining site. AFTAC, 1959 Unit History, 21. Like several other aspects in support of AFOAT-1's work subject to public release, such as announcements of Soviet test shots, this information was described as an AEC project as a cover story when connections were made to fallout sampling. The unit and other AWS assets were saved from even deeper cuts in part through an appeal to General Thomas Power of SAC in April 1960 as a concrete follow-up to his earlier complaints about what Power saw as the painful loss of useful fallout due to the test moratorium then in place.

[1025] These four sampling stations were apparently the same four Air Force balloon detachments pulling samples for AFOAT-1.

[1026] Lester Machta, Cover Letter for Draft Detlev Bronk Memorandum to Members, Consultants, and Guests of the National Academy of Sciences [Committee on Meteorological Aspects of the Effects of Atomic Radiation] Meeting of September 20, 1957," 9 December 1957, NARA RG 326.73, Project Sunshine, Box 2.

for collection of samples from as far north and south as the polar regions, as well as above the existing 90,000 foot balloon ceiling, thus it implicitly recognized Defense possessed or could acquire the means to access these regions of the upper atmosphere beyond the limited balloon program described in the letter.[1027]

The documentary context indicated Machta himself was aware of the U-2 and quite knowledgeable about AFOAT-1. As rapporteur for the NAS committee, he was responsible for communicating the group's work to Doyle Northrup of AFOAT-1 for review and approval. With "no adverse comments on either the statement or the letter to Mr. Northrup" Machta intended to finalize both, get Bronk's signature, and forward it all to Northrup, who apparently was the Air Force contact person on the matter.[1028] The correspondence indicated Northrup was the key to unlocking access to the stratosphere for fallout research, a situation that clearly established direct Air Force control over the pace and quality of any fallout research performed under its aegis, largely because it operated the only practical, reliable means to access this region of upper air.[1029]

Illuminating the Dispute over the Threat Posed by Wartime Fallout

The particular issue of the rate of strontium-90 deposition from a stratospheric fallout reservoir hypothesized by Willard Libby was the major research focus of the CROWFLIGHT stratospheric sampling program. Soil samples that worried the Weather Bureau provided concrete evidence of a troubling problem with fallout from atmospheric testing, which likewise disputed Libby's estimate that the existing stratospheric load of strontium-90 returned to earth slowly at a rate of 2.5% per year. Instead, the samples indicated accelerated exposures from a far more rapid and intensive deposition process. The AEC's estimate rather implausibly indicated

[1027] Among committee members and consultants listed in these Project Sunshine documents, those most likely cognizant of the U-2 program prior to the MIT meeting were two representatives from the Air Research and Development Command, and Dr. Heinz Lettau, of the Air Force Cambridge Air Research Center. Lettau was brought to the United States in 1951 under Operation Paperclip. He specialized in modeling the interaction between the surface and atmosphere, an area of atmospheric science also of considerable interest to AFOAT-1. https://cee.mit.edu/onbalance/2010/september.

[1028] Lester Machta, Cover Letter for Draft Detlev Bronk Memorandum to Members, Consultants, and Guests of the National Academy of Sciences [Committee on Meteorological Aspects of the Effects of Atomic Radiation] Meeting of September 20, 1957," 9 December 1957, NARA RG 326.73, Project Sunshine, Box 2.

[1029] The CIA's U-2 fleet was devoted to overflights of "denied" territory to capture imagery. The unit history records of the Air Force's 4080th SRW(L) show its U-2 operations focused primarily on sampling during the same period prior to 1963, although it also conducted electronic warfare and imagery missions.

nearly 90% of the strontium-90 generated by testing to date remained aloft.[1030] The subject of residence time of strontium-90 in the stratosphere was of great interest to the AEC and the Air Force. Libby's theory stretched the time aloft for the isotope to decay over a longer period of time. On paper, this diminished the relative intensity over time of the contribution that stratospheric fallout from high-yield explosions made to surface exposures from strontium-90 and associated isotopes as they settled down into the troposphere. The Weather Bureau's soil samples suggested this was not the case.[1031]

To reliably capture and return samples from high altitude CROWFLIGHT utilized U-2 aircraft from SAC's 4080th Strategic Reconnaissance Wing, the Air Force's counterpart to the CIA's Project AQUATONE U-2 fleet.[1032] In contrast with the primary product of AQUATONE, aerial imagery, CROWFLIGHT was among the multiple missions associated with fallout sampling and other aspects of nuclear intelligence that dominated the history of the 4080th between 1957, when the U-2 entered Air Force service, and the 1962 Cuban missile crisis. After 1962, the aircraft's role shifted towards imagery conducted by the Air Force with the fading away of CIA U-2 operations amid the plethora of new imagery associated with satellite photo-reconnaissance and, eventually, a lessening demand for fallout sampling that followed the end of atmospheric testing by the first three nuclear powers after ratification of the 1963 LTBT.[1033]

CROWFLIGHT involved a series of specific sampling profiles of the stratosphere, flying from bases in the United States and elsewhere on missions that ultimately ranged from the North

---

[1030] Hewlett and Holl, *Atoms for Peace and War*, 328-331. AEC data indicated that only 3% of CASTLE series fallout "could be accounted for worldwide." The AEC initially argued the explanation was that most went into the Pacific near the test site, but the British instead argued that most remained aloft. The difference meant that maximum permissible body burden would be reached after only 110 to 170 megatons of fission yield, rather than 11,000 to 17,000 megatons predicted by the Americans. CROWFLIGHT's initial findings apparently verified the British position, which Libby argued meant it would be held aloft in the stratosphere long enough to substantially decay. The soil samples subsequently demonstrated both more intense and rapid deposition of the stratospheric fallout. The findings also suggested that the dramatic upward revisions of the 60 megaton limit to 2,000 megatons of yield or more that subsequently were defined by GABRIEL were either groundless or intentionally contrived to accommodate the Air Force's desire to use high yield weapons.

[1031] Either the soil samples were accurate or the calculated fallout fission yield for the weapons tested during CASTLE was dramatically underestimated, which would mean even more fallout remained aloft.

[1032] 4080th SRW Operations Order No. 74-57, "CROWFLIGHT," 11 October 1957. While the order to initiate CROWFLIGHT came in October, the unit had been training for it since at least late spring after the initial cadre of training personnel departed the CIA's Ranch next to NTS in Nevada for Laughlin AFB, Texas to begin crew training on the U-2.

[1033] 4080th SRW Unit History, 1956-1965, Air Force Historic Research Agency, Maxwell AFB, Alabama. Declassified as a result of William Clinton's 1995 Executive Order 12958, the more than 10,000 pages available in this unit's history provides a remarkable insight into the early operational and technical history of the U-2.

Pole to south of Patagonia.[1034] Because the tropopause varies with latitude and season, samples were gathered at a variety of heights up to the service ceiling for the early model U-2, somewhere above 70,000 feet. Samples analyzed for Project Sunshine focused on strontium-90 and related isotopes, with sample collection overseen like other sampling operations by AFOAT-1 technicians. Mission aircraft flew with both gas and particulate samplers, suggesting as broad a range of interest in what might be available at altitude as when the U-2 was being directed on a "special" mission at specific Soviet test plumes. Some limited detail on mission criteria and profiles became available with the Clinton-era declassification of the 4080th SRW unit history, but AFOAT-1 involvement was described only cryptically for the most part in those documents.[1035]

Stratospheric Science

The Weather Bureau committee's collective nominal ignorance about the general nature of the U-2 program apparently ended at a 27 September 1957 meeting, when Harry Wexler noted they were informed about an "AFSWP aircraft program" while noting that "some of the committee members have had limited access in other capacities."[1036] While the memorandum confirmed the group was briefed on capabilities of the system, it left an open question what details were given or the aircraft's primary purpose, given the intense compartmentalization the letter intimated stood between the data and those who needed it. Wexler's 9 April 1958 memorandum contained a significant sign of change on that front in the form of a new "consultant" to the committee, Walter C. Singlevich. While the distribution lists of 1957 letters from Wexler to the committee included organizational affiliations for each member and consultant, the omission of these descriptors in the 1958 memo absolved the record from noting

---

[1034] The primary bases utilized included Plattsburgh AFB, New York, Ramey AFB, Puerto Rico, and Ezeiza AFB (Buenos Aries) Argentina.

[1035] From late 1961 to the 1963 ratification of the LTBT, the 4080th SRW annual unit histories describe often hectic efforts to keep up with the sheer volume of fallout emanating from the Soviet Union. Once the test ban treaty went into effect, the U-2s continued to sample at a somewhat more methodical pace for about a year. The mission then underwent a steep decline as SAC shifted these resources to imagery collection as the unit's primary mission. In the aftermath of the LTBT, this was an indication that the Air Force believed aerial sampling could be largely confined to confirmatory use in case other LRD techniques indicated a nuclear explosion had taken place.

[1036] Harry Wexler, Letter to "Members, Consultants, and Guests of the National Academy of Sciences Committee on Meteorological Aspects of the Effects of Atomic Radiation," 8 April 1958, NARA RG 326.73, Project Sunshine, Box 2. Again, it was an intentionally distractive understatement, given Wexler's long record of working closely with AFOAT-1 and Machta's leadership of the Weather Bureau team working closely with the intelligence unit. It is notable that CROWFLIGHT documents reference it as "in support of AFSWP operational requirements." 4080th SRW Operations Order No. 74-57, "CROWFLIGHT: Supplement I," 9 June 1958, 5.

Singlevich's affiliation with AFOAT-1.[1037] What was clear from the letter was internal controversy was already stalking their work.

> A copy of Dr. Libby's March 27, 1958 talk is included. Dr. Machta and Mr. List have taken exception to some of the data and conclusions in the talk and would like to send these to all members…it would be preferable to send comments by all members rather than those of only Machta and List…therefore soliciting remarks which any of the members or consultants, may wish to communicate to other members through this channel by April 20, 1958.[1038]

Machta and List began by noting many of their concerns were communicated to Libby before he delivered the disputed address, but Libby apparently proceeded without acknowledging the issues they raised. They argued Libby's handling of data tended to smooth out and make more uniform fallout deposition rates, a marked difference from the ongoing observations of considerable unevenness indicated in the data noted by Machta and List.

The net effect of Libby's mischaracterization of the data minimized the peaks in total fallout deposition recognized from the soil samples, which occurred as focused bands arrayed west to east across the continental United States. Libby would soon be awarded the 1960 Nobel Prize for his work on carbon-14 dating, but Machta and List proffered a brutal observation about the quality of the AEC director's research. Besides the issues with strontium-90 deposition rates, his critics found him particularly wanting in his analysis of global fallout deposition rates.[1039] The argument's importance was hardly obscure. Libby's model presumed a continuing dilution of fallout as it dispersed into the environment. Instead the data showed uneven deposition rates from global fallout. These peaked at 45 degrees North, essentially in a band bisecting the upper middle of the continental United States from Portland, Oregon, to Minneapolis-St. Paul, Minnesota, then across the border through Ottawa, Ontario and on eastward. Machta and List

---

[1037] AFTAC, *50 Year Commemorative History*, frontispiece. Accompanied by his picture, this volume was dedicated to Singlevich and his career with AFOAT-1 and AFTAC from 1952-1992, when he passed away while still on the job. The exceptional regard for his service was further memorialized when the new AFTAC headquarters building was dedicated to him and an Air Force officer long associated with the unit in January 2014. http://www.25af.af.mil/news/story_print.asp?id=123403628. Another measure of Singlevich's singular importance to the history of AFTAC was his relief by Congress under private law 87-343 on 10 April 1962 from obligation to repay excess compensation mistakenly credited to him during the period from 1958 to 1960 when he was engaged in the work noted here. http://www.gpo.gov/fdsys/pkg/STATUTE-76/pdf/STATUTE-76-Pg1286.pdf.

[1038] Harry Wexler, Letter to "Members, Consultants, and Guests of the National Academy of Sciences Committee on Meteorological Aspects of the Effects of Atomic Radiation," 8 April 1958, NARA RG 326.73, Project Sunshine, Box 2.

[1039] "Global" fallout was that injected high enough into the atmosphere to reach the stratosphere, typically only achieved during tests of thermonuclear weapons. The much lower yield of most fission weapons confined their fallout to the troposphere, as the fallout plume from these shots typically did not penetrate the tropopause.

hypothesized a combination of test sites close to 45 degrees North and global circulation patterns that converged and brought fallout along from other sites in the hemisphere further north and south (the USSR's Novaya Zemlya and the United States Pacific Proving Grounds) created this distinctive pattern.[1040] Libby's smoothing of the data distorted the peaks of deposition away from the more complex behavior Machta and List described. Their preliminary findings significantly undermined his argument that a beneficial process of stratospheric fallout dispersal lessened the threat posed by the massive fallout produced by thermonuclear weapons and which the AEC had depended on in its representations to the White House going back to at least its December 1955 report to Congress.

> It shows rather clearly that the stratospheric fallout is pronouncedly non-uniform with a peak in the north temperate latitudes[1041]…The difference is not large but the figure definitely misleads the public…[the errors] all happen to be in the sense of making the model look better than it is.[1042]

Beyond locating the most intense fallout over some of the most densely populated areas of the Northern Hemisphere, Machta and List also noted another significant error in the return rate of strontium-90 estimated by Libby.

> The hold-up time in the stratosphere is also a meteorological problem. Dr. Libby has estimated that the removal is at an exponential rate of about 10% of the stratospheric content coming out each year…this evidence, the best available, suggests that the rate at which the strontium-90 is leaving the stratosphere is about 20% per year, if the amount of strontium-90 added to the stratosphere is correct…the carbon-14 data, if anything, more consistent, with a 20% removal rate…Although we have emphasized that the removal rate is 20% a year or more on the average, it should be pointed out even more strongly that we are entirely unsympathetic to the use of a fixed percentage removal independent of the latitude or altitude at which the material is present in the stratosphere…We are almost positive that there is nothing unique about the tropopause except that it is the bottom of the stratosphere.[1043]

[1040] Lester Machta and R. J. List, "Meteorological Interpretation of Strontium-90 Fallout," 1 May 1958, NARA RG 326.73, Project Sunshine, Box 2, 6. The band centered on 45 degrees North extended from about 30 degrees to 50 degrees North.
[1041] Lester Machta and R. J. List, "Meteorological Interpretation of Strontium-90 Fallout," 1 May 1958, NARA RG 326.73, Project Sunshine, Box 2, 3.
[1042] Lester Machta and R. J. List, "Criticism of Dr. Libby's paper, 'Radioactive Fallout,' delivered in Lausanne, Switzerland on March 27, 1958," NARA RG 326.73, Project Sunshine, Box 2.
[1043] Lester Machta and R. J. List, "Meteorological Interpretation of Strontium-90 Fallout," 1 May 1958, NARA RG 326.73, Project Sunshine, Box 2, 6.

Thus, beyond the geographical concentration just described, fallout's net deposition intensity was also significantly greater because of the 100% or more increase in the rate of return of fallout lofted into the stratosphere Machta and List described versus Libby's uniform deposition model. Libby's embrace of the "tropopause as protective barrier" theory appears to have arisen out of efforts to account for the total radioactivity produced by thermonuclear weapons, a component of AFOAT-1's capability to track and analyze Soviet test debris and other fallout. Their massive plumes, which punched a significant portion of their radiation into the stratosphere, caused delay in fallout's return to lower altitudes, but the tropopause did not act as a long term barrier holding fallout back in an " atmospheric reservoir" while it decayed, as Libby believed.[1044] Instead of a lengthy stratosphere residence time, the data showed a much shorter period of decay that returned more intense fallout as the predictable result of both current testing and potential wartime use, since many targets also existed along or near this latitude.[1045] These increases also appeared to follow a seasonal pattern, with significantly increased deposition during spring in the Northern hemisphere.[1046]

Machta and List's information undermined theoretical assumptions Libby made that the tropopause limited the return of fallout by some as yet unexplained mechanism, allowing it to safely decay before returning to the surface. Concentrated by geographical origin and meteorological processes, Machta and List noted they "observed accumulated deposition, from whatever source, equals 25 mc/mi² in the latitude band from about 30º to 50º N…The rate of injection of strontium-90 into the stratosphere is 9 MT/year or 4.5 mc/mi² averaged over the earth." Using Libby's model (10% yearly stratospheric fallout with uniform deposition rate) and their own (20% yearly non-uniform rate), the report calculated the projected cumulative exposures as if the tests stopped in December 1957 (they did not, as it was noted in the discussion as a factor making these 1958 predictions more conservative than intended.) The two models then calculated under the assumption testing continued at the 9 megaton per annum rate

---

1044 Libby's mistake seemed to assume that the same process that tended to make the tropopause a barrier to upward movement into the stratosphere would likewise prevent the return of radioactive material as fallout that thermonuclear explosions injected, overcoming the tropopause's limits. If it was a barrier at all, the tropopause was very permeable and one-way in its effects.

1045 Attacks concentrated on targets near 45 degree North would intensify the differential deposition effect and accelerate the onset of observable fallout effects.

1046 Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 4. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

for 100 years. The cumulative result was a disturbing 354 mc/mi² with Libby's uniform distribution formula or as much as the even more alarming 540 mc/mi² with Machta and List's non-uniform model. [1047]

> At about 45º N, the latitude of the heaviest fallout, the non-uniform stratosphere model predicts about 75% more than the uniform model.

In effect, continued testing was essentially a drawn-out war, at least in terms of its fallout.

Although Machta and List's argument was primarily about stratospheric or long term fallout, the data for tropospheric fallout showed similar behavior at lower levels when it was studied. Both test series examined, one in Nevada, the 1953 UPSHOT-KNOTHOLE test series, and the other in the Pacific, 1954's CASTLE series, likewise created sharp profiles of increased deposition at the respective latitudes of the test sites. This cumulative data for U.S. shots was added together with Soviet and British contributions to arrive at a total for global tropospheric fallout. Graphs of it shared a similar pattern as the observations about stratospheric fallout. When totaled across the Northern Hemisphere, the overlapping data blended together, even as the observed higher readings tended to match the latitudes of national test sites. The graph of total cumulative tropospheric fallout deposition versus latitude was then superimposed on a similar graph of stratospheric fallout. Stratospheric fallout's dramatic spike in deposition peaked at a rate roughly five times the rate of the peak tropospheric fallout in the Northern Hemisphere.[1048] The location of the stratospheric fallout deposition peak, with its feet rooted amongst the lesser tropospheric peaks created by testing at national proving grounds at different latitudes, strongly suggested the pattern of concentration Machta and List observed brought the heaviest injections of stratospheric fallout from thermonuclear test grounds to the north (Novaya Zemlya) and south (Bikini Atoll and the associated Pacific Proving Ground) together by an as yet undefined global circulation process to create the band of heaviest deposition density centered along 45º North. Understanding that process meant understanding it required joint action to alter, given stratospheric fallout now was a common inheritance of the global population, even as the irony of it falling more heavily on those who felt the need for such weapons went unremarked. The

---

[1047] Lester Machta and R. J. List, "Meteorological Interpretation of Strontium-90 Fallout," 1 May 1958, NARA RG 326.73, Project Sunshine, Box 2, 7-8. While the U.S. typically only exceeded the 9 megaton number every other year when it tested high yield weapons in the Pacific, in combination with intensified testing by the USSR, annual global multi-megaton yield totals appeared as if they were likely to be at or about the 9 megaton figure.

[1048] Lester Machta and R. J. List, "Meteorological Interpretation of Strontium-90 Fallout," 1 May 1958, NARA RG 326.73, Project Sunshine, Box 2, Figure 2 and Figure 4.

information about it was classified; the political import of such findings was obviously momentous, given Robert Cutler's earlier troubling observation on the political implications of fallout for the Eisenhower administration.

Understanding the import of this finding also suggests an important analogy at the environmental level of the action of young bodies storing away iodine-131 in their thyroids at rates many times higher than adults because of a combination of the bio-concentration of the short-lived isotope into milk in its rapid passage through the food chain and the rapid metabolisms of children. While Hedley Marston's efforts in tracing iodine-131 in Australia were pioneering in terms of fallout science done outside of formal government direction, it was the 1957 Windscale accident that brought the iodine problem into public focus.[1049] Begun as an assessment of the global fallout ecology at least partly in order to unwind the disturbing direction of research on the limits of nuclear war GABRIEL took at a most inconvenient time for thermonuclear research, by 1958 Libby's Project Sunshine found itself under the lens for its myopic focus on strontium-90. In secret, the problem of fallout's empirical effects was increasingly recognized as far more substantial than ephemeral, even as the AEC continued to argue it was inconsequential to the public. Fallout did not have a mind, but it had a mind of its own. Fallout's unquenchable independence from control by national security structures wedded to nuclear weapons represented an ongoing process that corroded their military utility at the same time it called into question foundational issues such as the reliability and value of their deterrent effect.

Evidence in NARA's Project Sunshine documents, as well as others previously discussed here, clearly suggested the often tenuous connections, obscured because of their sensitive nature, between research and intelligence. Other evidence suggested neither Walter Singlevich's sudden availability as an adviser or Doyle Northrup's signing off on the plans solely defined AFOAT-1's interest in the research problem set before the NAS committee. An oral history transcript

---

[1049] Cross, *Fallout.* A useful deconstruction of Cross' short, but highly informative and engaging transnational story of Hadley Marston's documentation of the spread of iodine-131 from British tests was too lengthy to include here. Cross argued effectively that the British wanted such data suppressed to avoid embarrassing revelations about its widespread contamination of Australian lands. What Cross did not know was that the titular head of the Australian rad safety group associated with the tests was at the same time the manager for coordination of British nuclear intelligence efforts in Australia. The conflict of interest this outlined, but which Cross was not cognizant of, was far more significant than the case Cross was able to construct from the available documentary evidence at the time he wrote. In many ways, this Australian example paralleled the manner in which declassification of the full transcript of the Oppenheimer hearing, in concert with other subsequently available evidence, outlined a very different view of even more significant conflicts than those that formally precipitated the 1954 proceeding.

from an interview with Lester Machta made clear that, as in Australia, even when usefully engaged in legitimate research, his team often acted as creatures of the intelligence services, sometimes witting, sometimes not.[1050] With outside contractors, AFOAT-1's interest was usually thoroughly disguised, but Machta's team was an exception in generally understanding how their work applied to the unit's mission. As with the Oppenheimer hearing, the organization's interest was present in the record – at least after declassification – even if at times still superficially disguised, was indicative of the relative importance of the issue at hand to the Air Force. Along with the timing of its meetings that addressed the issues raised by the most recent test series, REDWING and PLUMBBOB, while moving forward with opportunities presented by the upcoming HARDTACK series, the urgency of addressing fallout in light of Machta's findings came into clear focus. It was clearly a matter of science, not public perception or even personal opinion. It certainly was not a matter of ambiguous "nuclear fear."

While the NAS committee pursued several experimental approaches to gather data on stratospheric fallout deposition, the means eventually chosen was to "salt" the two HARDTACK high-altitude shots, TEAK and ORANGE, with distinctive isotopes. This experiment was predicated on establishing the actual rate of return of stratospheric fallout to the troposphere in an effort to resolve the conflict between the competing uniform and non-uniform deposition models advocated by Libby and Machta, respectively. In an extension of the 4080th SRW U-2 program's CROWFLIGHT mission, the planes would initially pick up the samples indicating the movement of fallout from the TEAK and ORANGE detonations lower in the stratosphere, then track and sample the rate at which the marker isotopes appeared in the troposphere as it descended further towards eventual deposition at ground level.

Fallout's Political and Policy Effects

Despite the obvious limitations it maintained on access, its effort to provide carefully-vetted researchers with data obtained from samples through CROWFLIGHT was perhaps the strongest signal yet someone on the Air Force staff finally was coming to grips with the fact thermonuclear weapons and their associated fallout represented an irresolvable problem of national security. This development brought about a paralysis of strategy despite the newfound

[1050] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

clarity the U-2 contributed by both supporting basic research on fallout's atmospheric circulation and resolving the primary strategic ambiguities of the early Cold War brought on by Air Force intelligence's misreading the import of krypton-85 data on Soviet plutonium production. What were the real capabilities of Soviet nuclear forces? Was a disabling attack possible without inflicting intolerable damage outside the Soviet Union by means of fallout? While the NAS committee as a whole was not privy to it, thanks to the CIA's U-2 by 1958 Eisenhower and the Pentagon were all acutely aware the United States possessed military forces that outclassed Soviet assets in virtually every category, despite the anguished belief of many in a significant Soviet military advantage amid a threat accentuated by Sputnik.[1051] While SAC was potentially capable of quickly concluding hostilities, fallout would make the price that Americans might potentially pay for such a victory unbearable.

Because of the generally public nature of weapons acquisition and production in the West, the Soviet Union' leadership was always aware of the general outline of this substantial difference, but was naturally disinclined to clarify its own weaknesses. For Eisenhower and the Pentagon, the conundrum presented by Sputnik was how to reassure Americans their military was not falling behind, without directly addressing how knowledge came about of the vast superiority of force that became evident as the CIA's U-2 imagery clarified the actual balance of forces as decidedly in favor of the West. Certainly, the White House was loath to explain the miscues leading to the faulty analyses that formed the basis of the bomber and missile "gaps." Explaining what the pursuit of Oppenheimer accomplished would be even more difficult. At the same historical moment, just as fallout undermined the military utility of nuclear weapons, the research effort supported by the U-2 undermined the utility of using fallout to produce intelligence by producing empirical evidence of fallout's increasingly clear threat from testing alone, as well as from war itself.

Sometimes, You Need a Weatherman to Know Which Way the Wind Is Blowing

As with other aspects of nuclear intelligence, when public announcements of Soviet tests made it obvious someone, somehow was counting Soviet tests even as the AEC took credit for it, Machta remained at work, outside the AEC and Department of Defense, but as part of the same cohort. It was an independent set of eyes for science that proved invaluable. Machta entered

[1051] Pocock, *50 Years of the U-2,* 151-152. Nonetheless, General Thomas Power continued to insist the "missing missiles" were out there, somewhere.

meteorology through military service and in a manner that provided an interesting bookend to Paul Fackler's semi-intentional diversion of his sampler and its crew into the nuclear cloud at SANDSTONE, verifying the feasibility of using aerial samplers to document potential Soviet testing. Fackler hailed from Tolono, Illinois in southern Champaign County. Machta's especially intimate career that eventually focused on fallout included a stint at Chanute Air Force Base, outside Rantoul, Illinois in northern Champaign County, where Harry Wexler was among his instructors in the weather forecaster course during World War Two. After the war, Machta went to MIT for his doctorate from 1946 to 1948. Then Wexler, directing research at the Weather Bureau, offered Machta a job.

> Although we couldn't talk about it at the time…Harry Wexler brought me in to be in charge of the unit he called "Special Projects Section" (a meaningless title), it was to work in an area involved in atomic energy…Wexler at that time was extremely powerful in military advisory circles. He knew Colonel Ben Holtzman…also heavily involved in atomic energy matters, so when AFOAT-1, among its different charges, was going to try to detect radioactivity in the air, they realized that winds would carry that radioactivity and AFOAT-1 ought to have some knowledge of such air transport. So they gave [Wexler] a small amount of money to set up a unit in the Weather Bureau to study winds primarily coming out of the Soviet Union…it was for that job he brought me in…the Office of Management and Budget…made a decision that the other agencies of the government ought not set up their competitive weather services…that's why the Air Force came to Wexler presumably, to ask him to work out AFOAT-1's problem, rather than set up a new weather unit. The AEC was in the same boat.[1052]

While Machta directly noted the importance of accurately reporting Soviet weather data to assist AFOAT-1's mission, left unsaid was the fact that such data was also essential to strategic operations, including execution of SAC's war plans. Between the two missions, already intertwined as they are in this narrative, it was imperative that tracking of this data was continual to facilitate sampling operations.[1053] Likewise, the need for constantly updated weather data within the USSR also reflected AFOAT-1/AFTAC's discrete supporting role in SAC's warfighting mission, a deeply buried aspect of its mission serving to make information about it

[1052] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 1-5. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

[1053] SAC was also a user of one of the first mainframe computers, operating it for weather forecasting purposes to both direct sampling flights by aircraft such as the 4080th's U-2s and to direct its bombers as operationally necessary.

even more a touchy subject than expectations of its sensitivity due to its relation to nuclear weapons and strategic intelligence superficially indicated. During war, knowledge of fallout's drift and intensity would be crucial to intelligence gathering and warning to take shelter during ongoing operations. Likewise, the unit's ability to instantaneously detect the location of nuclear explosions would in battle damage assessment.[1054]

Noting Harry Wexler was chief of research at the Weather Bureau after World War Two and that the Office of Management and Budget had a policy of directing agencies with weather research needs to engage with the Weather Bureau, rather than create their own parallel weather agencies, Machta's oral history interview related background information strongly suggesting knowledge of the unevenly distributed fallout originated within the Air Force itself in the course of operating the AEDS.

> …there was a concern as to whether or not the Soviet Union would or would not be able to develop the atomic bomb, and if they did, how would we know this would be the case? A decision was made to assign this problem to the Air Force, and an Office of Atomic Energy was set up by the Air Force called "AFOAT-1."[1055]

The cover was deep and still strong in 1958, but Machta and the small group he directed within the Weather Bureau were there almost from the beginning of this narrative.[1056] Treating fallout as if it was another natural phenomenon, discovery of Weather Bureau involvement was another example of how this project moved forward incrementally by looking in likely places and finding, repeatedly, surprisingly robust connections. Machta's name came up periodically in the course of research, but his specific contributions and those of the Weather Bureau were

---

[1054] AFOAT-1, 1947-1953, 1954, 1955, and 1956 Unit History. See Table of Contents for "Warfighting" chapter page numbers in each. Following Joe-1, AFOAT-1 began considering what contributions were within its capacity to supply in the event of war. This led to the CODY study, which suggested ways to apply existing intelligence capabilities to bomb damage assessment. SAC was enthusiastic, but Air Force Staff in Washington was less so. The idea bounced around and was at various points between 1950 and 1955 approved and forwarded, disapproved, studied further, and embraced as a "moral obligation" by AFOAT-1 in the event of an outbreak of hostilities. Eventually, a wartime mission was formally adopted in 1955 and subsequently evolved into space-based capabilities, given that a watch over the Earth's surface for surreptitious testing provided instantaneous warning capabilities to do the same in war.

[1055] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 4. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

[1056] Lester Machta, "Finding the Site of the First Soviet Nuclear Test in 1949," *Bulletin of the American Meteorological Society*, Vol. 73, 1797-1806. ©American Meteorological Society. Used with permission. Machta was present to help with calculating and backtracking winds from within the Soviet Union during the post-detection confirmation phase of Joe-1 in September 1949.

obscure until a transcript from his 1993 American Meteorological Society oral history interview came to light and made these connections explicit.

Somewhat optimistically, Machta recalled fallout was not completely without value beyond intelligence purposes, observing its scientific utility in what was essentially a giant experiment with the earth as its laboratory and its population as test subjects.

> …in the early days following radioactive debris contributed significantly and perhaps even more, they stimulated some of the global circulation modeling.

As Oppenheimer noted in supporting the 1952 State Department proposal to pursue an agreement with the Russians to forego any immediate effort to test a thermonuclear weapon, Machta understood there was no means to conceal an atmospheric test of a thermonuclear weapon or to prevent identification of it as such.

> …when the first megaton yield hydrogen bomb took place which put radioactivity into the stratosphere [IVY MIKE, 10.4 megaton, 1 November 1952], each spring thereafter, even with no new tests going on, we found radioactivity being deposited on the ground. And it got to the point where we knew that the stratosphere was emptying itself into the troposphere mainly in the springtime…[1057]

Machta was not a man given to running in an ideological rut, as he discussed his slow-growing realization something was profoundly disquieting about the data.

> In retrospect, I'm not sure if I knew now what I knew then, I would not have been so keen to have been a party to the testing of nuclear devices. At the time, we were told by Admiral Strauss and by others that the Soviet Union was a menace to us – and maybe then they really were – and we had to test our nuclear weapons. Some people suffered on account of it. I just tried to minimize the fallout on populated areas.[1058]

Thus, four years after Robert Oppenheimer was forced out of government in disgrace, in substantial part due to his raising the issue of fallout as a limiting factor on the use of nuclear weapons, both Walter Singlevich and Lester Machta, almost singularly qualified in their respective fields of tracking fallout and compiling data to track the consequences of its spread, were in position to digest and outline an overall view of the situation of fallout's negative impact

[1057] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 6-7. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.
[1058] Ibid, 7.

on national security policy. They found themselves in a meeting in 1958 as momentous and consequential in its own way as the 1956 meeting between Eisenhower and the Joint Chiefs that Campbell Craig identified as a turning point on presidential direction of nuclear strategy.[1059] While the public defense of nuclear strategy, as well as testing, continued, behind closed doors the wheels were falling off defense policy centered on nuclear weapons because of fallout. The consequences of fallout from nuclear war seemed remote until one looked at the compelling evidence of its accumulation simply from ongoing testing.

Machta's job was to accurately explain what was underway with the fallout already in the atmosphere. In contrast to GABRIEL's attention to establishing an ultimate, yet still theoretical limit on wartime weapon expenditure, the Weather Service program focused on tracking fallout as it moved through the environment in the present. The basic starting point was the calculated production of fallout from each device detonated according to its yield.[1060] Then the rate of its return to earth was calculated with the goal of determining its accounted-for volume, as well as determining the remaining "reservoir" of fallout. With the limited yields of most fission weapons and their relatively quick return or deposition rate due to precipitation and other processes acting upon this fallout as it generally pushed no higher than the troposphere, the calculations involved were akin to those in the krypton-85 collection program.

Thermonuclear weapons presented a far more complex problem, given their towering stems carried fallout directly to the stratosphere as their boiling rise broke through what many scientists, including Willard Libby, previously considered an otherwise largely impenetrable tropopause, depositing a large proportion of the massive quantities of fallout they generated into the stratosphere. By 1956, two years after CASTLE BRAVO raised the priority of fallout research in reflection of its impact on policy, Machta and other Weather Bureau scientists became convinced they knew where the fallout calculated as missing went – into the stratosphere – but needed evidence of it as well as estimates on how long it stayed there, how much remained, and how it returned to the surface. The problem was obtaining samples from this liminal area between the earth and space, given the limitations of balloons and rockets and the known incapacity of current aircraft to exceed altitudes above 60,000 feet.

[1059] Craig's assessment of the 1956 meeting began this chapter.
[1060] Something inferred from the available records rather than specifically described as such, a common problem with much evidence in this project as it filters out through the process of partial declassifications which suggests but often cannot offer definitive proof pending further record declassification.

> Machta remarked on the unique perspective and responsibility accorded by his work.
>
> At the time, the United States was the world leader in atomic testing and the science connected with it. And I think the leader as well in the consequences of the radioactive fallout from the nuclear tests. I was, at that time, among the few people who had knowledge of most of what was going on.[1061]

What an understatement. Keep in mind the Weather Bureau was an even more data-driven organization than the Air Force was. Narrowly focused on the collection, analysis, and interpretation of data, the Weather Bureau possessed unassailable credibility. Unlike Hedley Marston's outsider critique, which could be marginalized despite its disturbing data on fallout revealing significant official prevarications, Machta's insider version of fallout science could not be ignored or suppressed, at least internally. It was not a matter of interpretation or opinion in the vein of Oppenheimer's persistently inconvenient objections to the questionable value and nagging constraints of thermonuclear weapons or the global threat posed by SAC's war plans. Like the weather, it simply was.

Walter Singlevich's mere presence at the meeting was a substantial indication the Air Force was at last, at least in secret, taking fallout as a problem seriously. Unlike Machta's view of the meeting and its context, Singlevich's insights remain locked away.[1062] Machta's opinion reflects on the resiliency of the cautions about the constraints fallout imposed on the use of nuclear weapons, which Oppenheimer raised to the best of his ability, as did other scientists like Mark Oliphant, Hedley Marston, Karl Z. Morgan, and a growing host of others.

> I think I was misled, not being a health physicist in underestimating what potential damage might actually have occurred from the fallout from U.S. tests. Although by publicizing the fallout, as I did, I think the world got quite an abhorrence to nuclear testing and contributed, in my opinion, significantly to the nuclear test ban…[1063]

[1061] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 8. American Meteorological Society Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

[1062] As far as the author knows, no similar extensive oral history of a scientist within AFOAT-1/AFTAC has been declassified, with the exception of seismologist Carl Romney's. It is in two sections, Interview of Carl Romney by Kai-Henrik Barth on 1998 January 20, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA,www.aip.org/history-programs/niels-bohr-library/oral-histories/22786-1 and www.aip.org/history-programs/niels-bohr-library/oral-histories/22786-2. It is unknown what specific documents might exist in classified form for Singlevich. Doyle Northrup is known to have such a memoir, but application for a Mandatory Declassification Review of it yielded no results as of 2016. See discussion in Appendix C.

[1063] Lester Machta, oral history interview transcript by Julius London, 31 October 1993, http://nldr.library.ucar.edu/repository/assets/ams/AMS-000-000-000-159.pdf, 7. American Meteorological Society

Machta likely had not come to quite so fully-formed a description of how fallout's influence would reshape policy at the time of the 1958 meeting, but certainly his experiences then led to his eventual conclusion about the outcome, a conclusion driven by his data, not his opinion. His case was also apparently compelling enough to constructively engage the Air Force. While the service still played along with the pretense of designing "clean" weapons, that year's two HARDTACK series treated these designs as largely irrelevant afterthoughts.[1064]

Given AFOAT-1's management by the Air Force and direct reporting line to the Joint Chiefs of Staff, Singlevich's participation in the 9 April 1958 NAS committee meeting was certainly a clear marker the Pentagon had a dog in this fight. An effort to stall or stonewall such a project was certainly within the imagination and experience of the military, in particular the Air Force, given Oppenheimer's ordeal and SAC's longstanding stubbornness about the irrelevance of fallout to its planning process. That did not seem to be the case with the issues Machta and the Weather Bureau raised about fallout. While Oppenheimer's insider status did not prevent his suffering at the hands of inquisitors, for the most part Machta managed to avoid the marginalization of his ideas. If anything, circumstances suggest the Air Force facilitated this aspect of his work. There was little speculative about Machta's position, given it was based on data, rather than the far more diffuse and prospective hypothetical policy argument about their fallout Oppenheimer was forced by circumstances to rely upon in raising his cautions about the Air Force's reliance on the massed power of thermonuclear weapons.

Fallout Swerves Over the Line

The Air Force's refusal to declassify the detailed fallout data requested by the Centers for Disease Control and National Cancer Institute to better gauge its impacts reflects the studied, long-standing ambiguity of the U.S. government's commitment to resolving the relationship between empirical measurements of fallout exposures and the range of injuries statistically likely to result across human populations from exposure to wartime fallout. This left the actual risks plumbed by GABRIEL and subsequent studies on the potential outcome of nuclear war unresolved. Moreover, it also prevented an honest discussion about the actual military utility of the investments made in these weapons. Releasing this data would cast in concrete form the

---

Oral History Project, Archives, National Center for Atmospheric Research. ©American Meteorological Society. Used with permission.

[1064] See earlier discussion on HARDTACK, page 399-400 of this chapter, Hewlett and Holl, *Atoms for Peace and War*, 345; Hansen, *Swords of Armageddon*, IV-190-191.

limitations of weapons most now hope to never use. Nonetheless, whatever consequential value exposure data might eventually establish for health impacts from fallout, the two presidents under which the bulk of American fallout was created took decisive action to limit testing in anticipation of the outcome of diplomacy because fallout's presence in the food supply chain exceeded standards the federal government itself promulgated.

The political significance of exceeding the exposure standards was clear at the White House, given Robert Cutler's earlier statement about the domestic political dangers of fallout. Even if handled in discrete secrecy, these empirical factors threatened to throw fuel on the fires of public and diplomatic protest. In a disturbing development for those who argued the safety of exposure standards in testing compared to wartime fallout, these executive actions were taken, not because war produced threatening exposure levels, but because simply testing these weapons did so. However profligate both the United States and the Soviet Union were with their testing by the late 1950s, though, the volume of testing fallout paled in comparison with what war would bring. Previous work has often touched on these decisions by Eisenhower and Kennedy separately, but here they are examined as directly linked by context and circumstances, as the executive office of the president pulled for a permanent test ban and the AEC and armed services pulled for a limited test ban allowing them to continue testing underground.[1065]

By March 1959, Eisenhower determined he would press forward with policy and diplomacy to address what he saw as intolerable risk and proven liability, given most indications in the now-rapidly accumulating data were that fallout was widespread, increasing, and posed short- and long-term threats difficult to evaluate let alone mitigate or treat. For Eisenhower, beaten by the winds of change, fallout, and the fate of choosing some advisers poorly, the conclusive turning point on fallout proved a humbly empirical one. Greene efficiently summarized the circumstances, just as the dispute over stratospheric residence times that festered in the Weather Bureau was roiling the legislative waters for the AEC. Once again, with no public notice, behind the scenes fallout took its place in the thick of the dialogue squarely among other actors, making another cameo appearance on the way to a presidential decision about its fate.

[1065] The contamination of wheat was documented beginning with "Wheat Found Beyond Safe Fallout Limit," *Chicago Tribune*, 7 February 1959. Wheat received comparatively little press, but Kennedy faced a major media storm over milk contamination, beginning with "Fight on Fallout: Red Blasts Spur Hunt for Ways to Protect Humans, Crops, Milk," *Wall Street Journal*, 8 September 1961. Given only the Russians immediately resumed atmospheric testing (the Americans held off until 1962), the impulse to blame them deflected some of the criticism even though the responsibility was jointly shared.

> Ironically, AEC Commissioner Willard Libby convinced Eisenhower to abandon atmospheric tests…At a meeting on 6 March [1959], Libby briefed Eisenhower and the Cabinet that the amount of radioactive strontium-90 in Minnesota wheat was nearing dangerous levels…Moreover, a recent study concluded radioactive strontium-90 spent one year, instead of ten as originally believed, deteriorating in the stratosphere before returning to the earth...Libby's information had an immediate impact on Eisenhower, convincing him to not authorize any additional atmospheric tests for the remainder of his presidency…[to his advisers, Eisenhower] acknowledged "all available evidence indicates that nuclear testing is bad." Eisenhower revealed that he had "come to the conclusion that testing in the atmosphere was something we wouldn't do in any event."[1066]

Obviously, Eisenhower's conclusion was not something to be shared with the Soviet Union immediately, but instead was negotiated, another narrative likely to be better informed by articulating the history of the Air Force's efforts to build and operate the AEDS through AFOAT-1/AFTAC to the extensive political narratives of arms control. But sharing it directly with Congress, the American people, or even the Pentagon itself was also problematic for the reasons Robert Cutler stated earlier and more. Particularly interesting was how Libby managed to come off so well, considering he was forced into directly addressing the fallout issues at direct variance to the position he took against Machta and List's recent criticism. Greene saw Libby's artful landing, but not the clumsy maneuvering that preceded it that Machta and List described in the Project Sunshine documents.

Libby may have been saved by quoting the facts and acting on them once he was backed into a corner by circumstances, accounting for why he saw the need to act in March 1959 when he previously disdained the need for action.

> Libby stated that experts agreed that the maximum permissible dose levels of radiation ranged from 50 to 100 units, as contrasted with the present general level in individuals of 1-2 units. Samples of Minnesota wheat showed a radiation level of 105 in 1957 and 155 in 1958.[1067]

Libby continued to assert "the hazard of radiation to be very small compared to the other hazards of life." The president drove right into that thinking, illustrating how he now regarded this line of argument about test fallout as missing the forest for the trees in terms of public

---

[1066] Greene, *Eisenhower, Science Advice*, 184. Note that Libby gave yet another, even more pessimistic value for stratospheric residence time here, compared to his 1957 discussion with Congress about fallout reduction and specific discussion about residence times later in March 1958. See this chapter, 414-416, 448-452. It is important to note the seasonal characteristics of the fallout flow as described by Lester Machta, thus Libby's concern as spring drew near.

[1067] "Minutes of Cabinet Meeting," 6 March 1959, Eisenhower Library, Ann Whitman File, Cabinet, Box 13.

opinion, opinion that was certain to be inflamed beyond its already nearly untenable nature considering the Cold War context.

> The president concluded the discussion with a comment on the difficulty of any assumption there could be a nuclear war, since the radioactivity level from a massive attack would be just tremendous compared with what was evident in Minnesota wheat as the result of merely a few tests.[1068]

The need to change policy because of fallout based on its empirical effects was then clear behind closed doors within the cabinet. What the public heard about it was entirely different. The president's briefing notes for a news conference a few days later delivered a stay-the-course message. If strontium-90 came up, the president's response would be that Health, Education, and Welfare Secretary Arthur Flemming would shortly issue a "statement saying no reason to believe any health hazard at the present time."[1069]

Greene summed up the difficulties the president faced with his next steps by citing AEC Chair John McCone's assessment that a comprehensive test ban was a non-starter, joining in the armed services' support for underground testing as a feasible alternative they required.[1070] Edward Teller remained an enthusiastic backer of testing, pledging to continue the fight even after Eisenhower finally dismissed Lewis Strauss. Greene argued it was Killian's defection to the atmospheric only test ban camp that contributed to his own replacement in July 1959 as science advisor by George Kistiakowsky, a supporter of the comprehensive test ban.[1071] Greene focused on the role of personalities and institutional interests as the engines of change regarding fallout, but ultimately policy was made by the president; his views carried substantially more weight even if still insufficient to fully prevail against the hidebound national security bureaucracy. Giving partial credit to public and world opinion, Greene argued "the most important factor" was

---

[1068] "Minutes of Cabinet Meeting," 6 March 1959, Eisenhower Library, Ann Whitman File, Cabinet, Box 13.
[1069] "Pre-Press Notes," 11 March 1959, Eisenhower Library, Ann Whitman Files, DDE Diary, Box 39. Flemming must have been biting his tongue over such an announcement. Shortly after CASTLE BRAVO, Flemming, who was director of the Office of Defense Mobilization at that time, wrote privately to Ike arguing for the need for an immediate test ban, perhaps influenced by those serving on the Science Advisory Committee (SAC, but do not confuse it with the Air Force's SAC). SAC was the predecessor of the Presidential Science Advisory Committee organized after Sputnik. Greene, *Eisenhower, Science Advice*, 37-38, 72. Greene noted the marginalization of the Science Advisory Committee by 1954, because Rabi, James Conant, James Killian, and Robert Oppenheimer were members. In the case of Oppenheimer, of course, Greene overlooked the fact he was clearly on his way to being an ex-member by 1953 when Flemming found himself managing the Science Advisory Committee, although it was certainly the case that Oppenheimer's situation contributed to the Science Advisory Committee's marginalization.
[1070] Greene, *Eisenhower, Science Advice*, 160-162
[1071] Ibid, 166-167, 171.

a "broadened range of scientific advice."[1072] Eisenhower's long and often fraught relationship with both science and fallout certainly framed his decisions on national security in the last few years of his public service. This was another case where incomplete knowledge about the role of the AEDS led to a strong but ultimately insufficient argument, as it remained fundamentally soft in the center by only incompletely describing fallout's key role in shaping policy.

The argument that psycho-social factors predominated in human decision making in relation to fallout is not essentially wrong, but it fails to fully inform about the extent to which the lack of factual data to properly evaluate fallout's risks was a constructed and intentional ignorance. In this example, it happened even as Greene presented a litany of evidence about fallout's political, military, and scientific effects. Most telling was the primary reason Eisenhower and Dulles concluded a comprehensive test ban was preferable to the atmospheric test ban.

> "Eisenhower…privately discussed Gore's proposal [for a partial test ban proposal in Geneva as a backup to failure to achieve a comprehensive test ban] with Dulles. They were both concerned that banning only atmospheric testing would signal a reversal of the public assurances that there were no significant health hazards from testing.[1073]

Gore's proposal was also discussed by the Presidential Scientific Advisory Committee, which was just as alarmed about the clarity of the implicit message such a decision would send.

> …Bethe and Rabi reached a similar conclusion on the political implications of pursuing a ban limited to atmospheric tests. They wondered how the administration could make such a proposal "without national embarrassment and a severe propaganda setback."[1074]

Greene observed "Most PSAC scientists discounted the health hazards of fallout…" Most, however, were likely ignorant of GABRIEL's history. Although Rabi likely knew about it, it was uncertain how much others in PSAC knew about the ongoing CROWFLIGHT program. Bethe and Rabi of PSAC framing of their reaction to pursuit of only an atmospheric ban as a "severe propaganda setback" expressed fear that the government's public discounting of fallout's significance Greene concluded was underway could backfire if government suddenly issued

[1072] Greene, *Eisenhower, Science Advice*, 164-165.
[1073] Ibid, 169.
[1074] Ibid.

statements contradicting that stance.[1075] Most policy makers still believed they were dealing primarily in mistaken popular assumptions about fallout and the political costs it imposed, not a fundamental threat to the most powerful of all weapons systems. In this sense, Weart's findings on nuclear fear certainly account for the reaction of many of the actors involved, but this was an artificially myopic view, failing to take into account what was artfully hidden. Machta's findings on the concentrating behavior of global fallout deposition still awaited confirmation in the results of CROWFLIGHT, but work like his and that of Hedley Marston and other scientists demonstrated fallout's days as a useful if otherwise inconsequential secret were largely over as scientific scrutiny of it intensified.

Capped by the collapse of Libby's support for tolerating testing fallout and the crumbling of his overly optimistic theory of fallout deposition, the eventual fate of testing fallout was sealed, even as politico-diplomatic circumstances delayed and added complexity to the national security policy problems of the Cold War over the next four years. The Limited Test Ban Treaty was not signed and ratified until 1963 under another president. John F. Kennedy would inherit, not a *fait accompli*, but an urgent need, one Eisenhower ensured he was briefed on specifically in the transition.[1076] Despite tough talk of confronting Communism made during his campaign against Richard Nixon, which carried over into his brief, crisis-laden term, Kennedy, too, directed his administration to pursue nuclear diplomacy at least as ardently as it sought confrontation with the Soviet Union.

The 1959 Fallout Hearings

The 1959 fallout hearings in Congress were a further sign the Pentagon finally realized fallout was creating a fundamental political vulnerability. Its strategic dependence on nuclear weapons revealed a conventional arms "gap" of sorts. Amidst demands from Congress and the public for more information, the military asserted secrecy about fallout must continue or they would otherwise face increasing political constraints because fallout would be perceived as

[1075] AFOAT-1, 1956 Unit History, 132. Rabi's instrumental role in setting the Gaither report's critical look at the threat posed by fallout and the needs its threat suggested required addressing demonstrate the pivotal role he played in reshaping fallout policy on behalf of the president; he was most likely among PSAC members to be cognizant of the full breadth of fallout research. Importantly, he was among those given special briefings by AFOAT-1 on 8 October 1956.

[1076] Kennedy suggested several topics in advance of a meeting with Eisenhower on 6 December 1960, but "disarmament and nuclear testing" were not present on JFK's list as they were on Ike's in an undated preliminary memo in early December. By the day before, the order of Ike's list was rearranged, but retained disarmament and nuclear testing, with briefing papers attached.

limiting the use of nuclear weapons.[1077] May 1959 offered an extended reprise of the 1957 fallout hearings. Tellingly, whether for socio-political or empirical reasons, Hewlett and Holl drew a firm conclusion of fallout's growing influence on policy.

> The [1959] Joint Committee [JCAE] hearings amply justified the principals' conclusion that fallout had become a controlling factor in test-ban policy.[1078]

The corollary, given that fallout from testing had long been argued to be "safe" even if it might become a threat during wartime, was that if fallout from testing was determined to be problematic, it amplified the assumptions one could draw about its wartime impact and the implicit limitations this placed on war planning.

Indicative of growing Congressional and public doubts about whether the Commission took fallout seriously, in reporting on the AEC's efforts to promote "Fallout Research and Organization" AEC Chair John McCone was forced to humbly begin his statement by insisting the Commission was serious about fallout and devoting considerable resources to the problem.

> We do not take this question lightly; we have not dismissed it as unimportant to the people of this country and, indeed, the world…The equivalent of 800 scientists are engaged in this work….No Atomic Energy Commission information relating to radioactive content of the atmosphere and the amount of fallout has been withheld from the public or from the United Nations.[1079]

Despite his oath to testify fully and completely, McCone was nonetheless evasive, if not simply lying, on that and several other points he addressed.

> The AEC is the only agency in Government that has engaged in extensive research work in the sampling of the atmosphere and conducting fallout studies on a worldwide basis…I assure this committee most emphatically and unequivocally that so long as I am Chairman…I shall not be party to the suppression or distortion of any information bearing on the safety or health of the American public. [1080]

[1077] Hewlett and Holl, *Atoms for Peace and War*, 391, 393, 398-401. Congressional hearings on May 27-29 and June 3-7, 1957 by the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, titled *The Nature of Radioactive Fallout and Its Effects on Man*, were followed by another round, *Fallout from Nuclear Weapons Tests*, on May 5-8, 1959. The 1957 hearings included a proposal to accept a limit of testing at fifteen megatons amid expressions of fear of the negative impacts of a limitation or ban on morale and personnel at the national laboratories. Congressman Chet Holifield (D-California) charged the AEC with misleading the public about the "cleanliness" of high-yield weapons. At the end of a briefing for the president by scientists including Edward Teller, who newly assessed "clean" weapons offered a propaganda advantage over the USSR in event of a war. Eisenhower himself suggested giving "the other guy" the design as desirable.

[1078] Hewlett and Holl, *Atoms for Peace and War*, 555.

[1079] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2542-2543.

[1080] Ibid, 2543.

In part, McCone's description of what the AEC was supposedly engaged in used language that sounded suspiciously similar to the original 1947 orders issued by Eisenhower standing up AFOAT-1's mission.[1081] At a minimum McCone failed to explain that it was far from being solely the AEC's efforts he was describing. Rather, the project was in large part that of the secret Air Force intelligence unit on behalf of the AEC, with the AEC essentially making do with whatever information the military deigned to pass along, never mind the fact that the AEC was clearly not "the only agency in Government" engaged in this effort.[1082] The manifest conflicts of interest and the sheer lack of accountability implicit in McCone's shading of the truth about fallout research would have waved a red flag in front of the congressional bull if McCone had fully and completely disclosed it to the committee, given one goal of Congress was to ensure making at least a gesture toward independent oversight in protecting the public interest from fallout. Evidence of intensifying public interest in fallout was reflected in the heightened attention of Congress to the issue.

Fallout Finds Its Way Home

McCone's knowingly duplicitous hearing statement was in reaction to a controversy that arose between the two major Congressional hearings on fallout after McCone assumed the AEC chair following Strauss' departure after the 1957 hearing. As the 1959 hearing neared, concerns were raised the AEC was responding inadequately to the committee's request for a number of classified documents on fallout. Of greatest concern was a response by General Herbert B. Loper, the Assistant to the Secretary of Defense for Atomic Energy, to questions raised about the residence time of strontium-90 (28.8 year half-life) in the stratosphere. During the 1957 fallout hearing, testimony was dominated by Willard Libby's position on fallout's life cycle; Libby presented his estimate that injections of this isotope into the stratosphere resided there for an average of seven years before reentering the troposphere. With the relatively high yields of thermonuclear weapons depositing a large amount of strontium-90 into the stratosphere and the

[1081] AFTAC, *A 50 Year Commemorative History,* 1-4.
[1082] Ralph E. Lapp, "Fallout Hearings: Second Round," *Bulletin of the Atomic Scientists*, Vol. XV, No. 7 (September 1959), 302-307. Somewhat misleadingly, the AEC provided data on fallout research expenditures that showed the AEC spent $43 million in FY 1959, while the military spent about $13 million. Given fallout was a military problem and the Air Force controlled access to samples and classification of the data derived from them, McCone's argument that it was an AEC program was, at best, duplicitous and evasive. Lapp assessed the 1959 hearing's goal was to make the case for resumption of testing, despite global fallout testing totals that far exceeded the 10 megatons per year testimony at the 1957 fallout hearing suggested would limit fallout deposition to what were argued to be "safe" levels in 1957.

threat its bone-seeking properties posed to increased incidence of blood and bone cancers, an estimated residence time of seven years would allow a substantial part of the strontoum-90 to decay before it moved to lower altitudes and then into terrestrial food chains. But Libby's estimates were based on fallout from testing conducted only through 1956.

Gioacchino Failla, chair of the AEC's advisory committee on biology and medicine, argued that projected testing need also be accounted for by means of estimates, resulting in body burden limits for strontium-90 that exceeded current standards in about 28 years. Prior to HARDTACK during the 1957 fallout hearings, the AEC suggested there was a "safe" level of additional fallout, 10 megatons, that could be introduced annually into the atmosphere through testing by limiting new additions to no greater than the predicted rate of decay of fallout already aloft to avoid raising exposure levels from fallout deposited back to earth. [1083] Such reasoning presumed acceptance of already increased levels of exposure since 1945, as well as presumed that other nations like the Soviet Union would similarly limit their test programs. It also presumed the AEC could confirm how much fallout actually left the atmosphere, which the Weather Bureau data by 1958 suggested was uncertain.

In reality, Libby's theoretical assumptions were nearly as optimistic about the behavior of strontium-90 and other fallout as the Air Force's estimates of Soviet nuclear forces derived from krypton-85 monitoring were pessimistic. By 13 March 1959, Libby reduced his estimate of stratospheric fallout residence time to four years. A week later, General Loper had the misfortune of breaking the bad news to Congress that new data collected from the high-altitude experiments at HARDTACK suggested the stratospheric residence time was much shorter than originally estimated and even shorter than Libby's new estimate, just two years.[1084] Even worse, instead of being distributed relatively equally as Libby's 1957 model suggested, it confirmed Machta's and List's findings that global circulation patterns concentrated this stratospheric "drip-out" between 35 and 50 degrees latitude. The picture Loper painted was alarming, because most testing

[1083] Hewlett and Holl, *Atoms for Peace and War*, 375-380; Lapp, "Fallout Hearings, Second Round," 304. Failla may have been alarmed that the pressure to test high yield devices, given continuing demands from the Air Force on that front, would sharply increase testing yields and drastically shorten the rather favorable terms that Libby and Merrill Eisenbud calculated on fallout deposition.

[1084] Helen C. Allison, "News Roundup: Radiation Problems," *Bulletin of the Atomic Scientists*, Vol. 15, No. 5 (May 1959), 223. This data was collected by the CROWFLIGHT U-2 aircraft searching for fallout from HARDTACK shots TEAK and ORANGE. The two high-altitude shots were spiked with specific isotopes to distinguish their fallout from other samples. Loper's letter to JCAE chair Senator Anderson was largely based on preliminary analysis of samples taken by U-2s of the 4080th SRW in connection with the CROWFLIGHT program.

occurred in the Northern Hemisphere with the elevated drip-out latitudes covering most of the continental United States.[1085] It did not help that Congress was also complaining about being kept in the dark about ARGUS (after the story was leaked to the *New York Times*) and its secret nuclear shots above the South Atlantic that supplemented the high-altitude shots at HARDTACK and what it saw as Loper's selective approach to keeping Congress current on fallout.[1086] While testing of all high-yield devices and many lower yield ones was conducted in the remote Pacific, fallout was relentlessly finding its way home, rather than dispersing, making a telling point about how humans only imagined they were fully in control of nuclear weapons.[1087]

Loper's response was conciliatory, but somewhat arrogant, arguing several of the points had been previously communicated to the committee. Loper then proffered an argument that even more testing was needed to better understand fallout effects. It was not exactly what Congress wanted to hear, prompting Willard Libby to attempt to calm the troubled waters he successfully navigated previously in 1957. Libby disagreed with a revised estimate Loper offered for stratospheric residence time, insisting he had seen no evidence of it being less than four years.[1088] Libby argued his estimate of the current fallout present in the atmospheric "reservoir"

[1085] Letter from General Herbert B. Loper to Senator Clifford B. Anderson, 19 February 1959, reproduced in Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2537-2538. The relatively limited British testing in Australia made the only major contribution to Southern Hemisphere fallout during this early Cold War period. It is worth noting this interhemispheric limitation on the mixing of the atmosphere undermined the premise of southward-drifting fallout that posed the invariably fatal threat in *On the Beach*.

[1086] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2536-2537. ARGUS involved two high-altitude shots conducted from a Navy vessel in the South Atlantic. The objective was to confirm the Christofilos effect, which theorized nuclear explosions could create artificial radiation fields similar to the naturally occurring and then recently discovered Van Allen belts. Conducted in secret, leaks to the press brought questions from Congress, since the relevant committees were not notified. While generally termed an experiment in weapon effects in near space, the data also provided insights into detection of nuclear tests conducted in space for AFOAT-1.

[1087] Ibid. The lack of conceptual acuity about fallout was reflected in the belief that fallout somehow just continued dispersing to infinity, as implied in the many models created of fallout to support a number of studies beginning in the 1950s. RAND and other scientific contractors replicated this implicit belief in their models by omitting reference to termination of the model. In the environment, the course of dispersal eventually reverses, where various biological, chemical, and physical processes act to differentially re-concentrate each isotope. Thus, virtually none of the various AEC- and Air Force-sponsored models and studies broke through and followed fallout along its full cycle. Studies of fallout transport in the environment similarly have an obscure beginning, reflecting the construction of a silent, scientific disconnect within the cycle that, intentionally or not, served more to obscure than to delineate the empirical effects of fallout's life cycle.

[1088] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2536-2537. By 1959, Machta and List of the Weather Bureau already had advised Libby of their own findings, which provided data that clearly disputed Libby's claim here. Libby appeared to be counting on the secrecy to restrict access to the matter in conflict to conceal this falsehood in sworn testimony to Congress.

was equivalent to a total yield of 42 megatons. Libby acknowledged evidence was building for the thesis Loper articulated that atmospheric circulation concentrated fallout deposition in the temperate latitudes, i.e. between 35 and 50 degrees latitude, but insisted it was not conclusive yet.[1089]

Muddying the waters further, A.R. Luedecke, general manager of the AEC, then argued the differences and uncertainties between the two men's accounts reflected the active workings of science, not an attempt to deceive Congress. Luedecke did spill the beans partially when he revealed that tungsten- and rhodium-salted devices were used at HARDTACK, in surface-burst and high altitude shots respectively, as this data would help differentiate between fallout contributed by the Soviet Union and that from the U.S. and its allies and between surface shots and those detonated in the upper atmosphere for research purposes. Meanwhile, the Department of Defense insisted that only one sentence in its report to the committee on the issue was classified, but "the Department recommends that it not be discussed in public because there is not full agreement as to the interpretation of the data obtained so far."[1090] Small wonder McCone felt obligated to try to smooth the waters by insisting on the AEC's assertion that it was being entirely forthcoming on fallout data. Aiding him in this was a report issued by the 1959 General Advisory Committee, led by Warren C. Johnson, that insisted fallout was a negligible threat. This ended a long silence on the matter, as the 1950 GAC was never offered an opportunity to make its case to the public in such unrestricted fashion.[1091] Behind all the smoke and mirrors that the AEC and Defense used to walk Congress through on fallout, it was obvious that a pointed effort was being made to deceive the legislative branch about the effectiveness of policy changes already wrought by fallout and limit the potential flow of information about it over fear it might damage the nuclear intelligence effort, support for nuclear weapons as a whole, and threaten the limited efforts then underway to strengthen civil defense as largely pointless.

[1089] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2536-2537. Loper appeared to be referring here to data collected by CROWFLIGHT. Machta and List's argument would be strengthened by the CROWFLIGHT data, but had already been established by ground station soil sampling.

[1090] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2538-2541.

[1091] Ralph E. Lapp, "Criticism of the GAC Report," *Bulletin of the Atomic Scientists*, Vol. XV, No. 7 (September 1959), 311-312, 320. Lapp pointed to a "distressing lack of documentation or technical reference" in the GAC report's claim that natural exposures to low-level radiation, including from well water in Illinois, demonstrated the relative safety of fallout. Lapp's critique was in turn disputed by Eugene P. Wigner, "Critique of a Critique," *Bulletin of the Atomic Scientists*, Vol. XVI, No. 3 (March 1960), 107-108.

What was the connection between the congressional testimony and troubling data Loper and Libby exchanged fire over, the same data that the Machta and List of the Weather Bureau raised questions about? The data being discussed was produced by the ongoing CROWFLIGHT high altitude sample data collected by the 4080th SRW U-2 aircraft at the behest of AFOAT-1, along with a far more modest set of samples returned by a recent, marginally successful balloon sampling program even then in the process of being reduced from four detachments to one because of the limited results obtained.[1092] CROWFLIGHT representatively sampled whole air, primarily from the stratosphere, rather than trying to vector in on the concentrated plumes from specific test shots. Its samples were not typically as "hot" as the test shot samples and missions directly vectored against Soviet fallout plumes were, although the dangers of flying at altitude in the U-2 remained ever present for the aircraft's pilots.

1959: Fallout: Replacing the Life-Blood of the Air Force

Efforts to repackage the production of fallout through testing as an explicit yardstick by which to gauge the strength of American national security were well underway by March 1959, thus returning to the beginning of this narrative about fallout with a better understanding about the alarm expressed by General Thomas S. Power, successor to General LeMay as SAC commander, on the effect of fallout's loss on the Air Force after Eisenhower's test ban halt went into effect. To review, Power argued in secret to the Joint Chiefs of Staff (JCS) Americans needed to be exposed to a stark choice.[1093]

> [T]he JCS should request the Office of the Secretary of Defense (OSD) to launch a campaign to persuade the American people that fallout from nuclear weapons tests was a negligible hazard compared to the peril that would result from failure, through insufficient testing, to maintain an adequate nuclear deterrent.[1094]

[1092] AFTAC, *A 50 Year Commemorative History* , 139-141. Balloon sampling continued after the advent of the U-2 and the CROWFLIGHT mission, in part because it could reach higher altitudes than the aircraft could. There were some attempts to use rockets to collect samples at high altitudes, but it was costly with limited results. The rocket technique operated, mostly on a test basis, from 1961 to 1970, ironically utilizing the Genie nuclear-capable air-to-air rocket fired at the 1957 PLUMBBOB JOHN test. Fired upward at high altitude by its carrier plane, the rocket sampler could reach as high as 350,000 feet.

[1093] Beginning in 1948, Power served as LeMay's assistant in building up SAC prior to succeeding LeMay when he was promoted to Vice Air Chief of Staff. Power's SAC service was interrupted by three years beginning in 1954 by command of the Air Research and Development Command. ARDC was the successor of the Army Air Force command LeMay held when he worked developing what became AFOAT-1, thus remaining intimately connected to the issues surrounding nuclear weapons and their detection in the firestorm of criticism that erupted following CASTLE BRAVO.

[1094] Nalty, *The Air Force and Nuclear Testing*, 4. Whatever motivation Power had in opposing what even many in the Air Force considered an all but *fait accompli* end to atmospheric testing and new fallout by March 1959, he was obviously uncomfortable enough with the decision to speak out against it, at least behind closed doors.

Putting aside the fact Power seemed to not notice the Cold War Air Force had been engaged in a very similar, if studiously less specific campaign since 1947, Power explicitly framed the need to evaluate American national security in terms of its capability and freedom to produce fallout in order to develop new weapons to maintain the balance of terror. Another part of Power's comment invoked aspects of nuclear absolutism in his use of Russian fallout as the justification for American fallout, without noting the vast disparity in those numbers as of 1959. General Power saw the Russians as an obviously greater threat than any namby-pamby fallout ever could be and the weapons under his command as largely without limitations on their use. Whatever academic or ideological theoretical flavor one prefers to read them in light of, Power's words illustrate the strength and centrality of fallout's continuing influence on the policy cycle at the time. Power's candor, if not his wisdom, in problem formulation still left several things unsaid about the role and influence of fallout on the decisions of military leaders such as himself and others like LeMay and Twining.

As a publicly-recognized feature of high-yield weapons, fallout's threat – in the absence of other options – helped maintain the counter- direction of weapons development established by the Oppenheimer-led GAC, balancing against the influence of scientists like Teller and leaders like LeMay and Power within the Air Force leadership.[1095] This core group inside the Air Force remained enthralled with the quest for high-yield weapons long after it became clear the president saw no advantage in their military effects over increasingly accurate low-yield weapons. Recognition that fallout was a problem after 1954 thus resulted in an even more preponderant emphasis on development of smaller, more tactically agile weapons. Fallout facilitated Oppenheimer's continuing influence on stockpile composition while simultaneously limiting the influence of Teller's inclinations at Lawrence Livermore National Laboratory long after the man it was formed to undermine was forced out of government service in 1954.

The lack of fallout that prompted and energized Power's ire, helping explain the general's classified diatribe on the need to persuade Americans that they should think of fallout as tolerable, was due to the informal halt to testing by the three original nuclear powers that took effect at the end of 1958. Not bound by any diplomatic agreement, the United States could

[1095] Lapp, "Fallout Hearings: Second Round," 303. Lapp noted how the 1957 hearings opened a new, far more public phase in an intensifying transnational conversation about fallout. Its two-volume, often highly technical transcript was often referred to as the "Green Bible," with more than 20,000 copies distributed since the earlier hearings in 1957.

decide to end its participation in the moratorium if it must. The test moratorium was unilaterally proposed by the Soviet Union in 1958, with the United States and the United Kingdom joining independently in suspending testing. The Air Force began seriously fretting about the possibility of the test ban after Russian diplomats first proposed what was characterized as "an unspecified system of controls in return for a two-to-three year moratorium on testing," which was followed at the end of an earlier Soviet test series in March 1958 by the announcement they would cease testing soon. In August 1958, President Eisenhower announced his intent to join in a moratorium – on 31 October 1958 after the end of the already-scheduled HARDTACK test series. Power facetiously characterized the test halt's resulting dearth of fallout as "placing a severe strain on the nation's military strength." After Eisenhower extended U.S. participation in the informal test moratorium into the election year of 1960, the Joint Chiefs of Staff joined in supporting Power's anxieties, arguing "continuation of the unpoliced moratorium was an unacceptable military risk."[1096] The JCS claim that the test moratorium was "unpoliced" was a particularly laughable assertion, given the considerable efforts devoted to the capabilities of long range detection managed by the Air Force Technical Applications Center (AFTAC), the newly-named organization that assumed the mission of AFOAT-1 in July 1959, a unit directly under JCS command and control. It was a dubious contention made secure in the knowledge the president could not offer the public a classified refutation to it.

The Cold War canon holds the motivations for remarks such as Power's were a product of the need to continue development of various new nuclear warheads to equip a variety of new offensive weapons systems scheduled as a quick follow-on to first generation platforms; most important to the Air Force in 1959 and 1960 were those connected to the development of the Atlas and Titan intercontinental ballistic missiles designed to deliver thermonuclear warheads and due to replace legacy pilotless cruise missiles with a shorter range like the Mace and Matador. However, anti-ballistic missile (ABM) warheads were frequently cited in such discussions of developmental goals, given their "defensive" nature was often regarded as the preferable message to send given the controversy over the effects of their use. Certainly as commander of SAC, Power was interested in offensive strength. Power, like Twining, understood how important the role of the nuclear intelligence portfolio managed by AFOAT-1 was in justifying the power at his command. And no fallout meant that a major Air Force

[1096] Nalty, *The Air Force and Nuclear Testing,* 4.

intelligence system, the AEDS, no longer had access to the fresh stream of information it produced from Soviet testing debris. The Air Force's thirst for new weapons was not, however, the sole or even primary motivation behind Power's objection to the test halt, a need that was addressed satisfactorily by underground testing provisions in the eventual 1963 test ban agreement.[1097] Here the real value of fallout was the other side of the coin. The cut-off in information from Soviet fallout due to the moratorium on testing, which up until the 1958 test halt provided the primary underpinning of SAC's rationale for its own massive force expansion, was something that pained Power deeply.

It was a liminal moment centered on development of new technology, but not entirely in the way the Joint Chiefs cast it. The test moratorium proved to be a watershed in the shifting influence of intelligence approaches between the decade-long incumbent, nuclear intelligence, largely derived from the Air Force's operation of the AEDS, and imagery, provided at first by the CIA and Air Force U-2 fleets, then by CORONA and other follow-on satellite imagery systems.[1098] By the time testing resumed temporarily in 1961, space-based platforms provided a far more comprehensive picture of the actual Soviet threat, capabilities, and readiness, all factors more relevant in assessing the possibility of Eisenhower's central fear of surprise attack through two terms in office. While information derived from the AEDS was effective in generating worst case scenarios of Soviet nuclear power, its strategic weakness was in providing little rationale or nuance for anything short of a maximum effort reaction. The limitations of accuracy and analysis inherent in the various technological components of the AEDS network, even with the remarkably accurate krypton-85 method of assessing Soviet plutonium stockpile growth, served as a peculiar, but imprecise intelligence source to justify the scale of the postwar buildup of

[1097] The 1963 Limited Test Ban Treaty negotiated in lieu of a comprehensive test ban desired by Eisenhower permitted underground testing, which continue until the Cold War ended. In the absence of final ratification of the CTBT or other total test ban, the United States, United Kingdom and Russia continue to informally refrain from testing.

[1098] Philip Taubman, *Secret Empire: Eisenhower, the CIA and the Hidden Story of America's Space Espionage* (New York: Simon & Schuster, 2003), 238-239; "Satellite Reconnaissance: Secret Eyes in Space," Smithsonian National Air and Space Museum, Washington, DC, https://airandspace.si.edu/exhibitions/space-race/online/sec400/sec420.htm. CORONA was the code name for the CIA's original photoreconnaissance system and its imagery, directed by Richard Bissell, was derived from the Air Force's WS-117L satellite program. The name came from a member of his staff, whose favorite cigar was the Corona. In public, the first successful U.S. satellite, Discoverer, served as the cover story for CORONA work that could not be hidden, such as construction of a new launch pad at Cape Canaveral. On the thirteenth try, the first successful Discoverer mission in August 1960 proved the system's capabilities. Discoverer-14 returned the first images of the Soviet Union, with its film providing more coverage than all U-2 overflights to that date. The vastly increased coverage from space finally conclusively proved that the bomber and missile "gaps" were illusory.

SAC. AFOAT-1/AFTAC's work product was compelling due to its very nature, an effect enhanced by nuclear absolutism, leaving what some preferred to see as a blank check in terms of the scale of response required to address the threat it described. With a sales force like Vandenberg, Doolittle, LeMay, and Power, aided by the lobbying of a quickly growing Air Force Association, the ambitious Air Force more often than not made its case for that budget and force level number to be larger rather than smaller during the nineteen-fifties. Walter Rostow's call to essentially pay any price to counter the Soviet threat was but one example of the prevailing mindset among Air Force boosters.

> …there is no proof whatsoever that the Soviet military effort is being reduced, and there are no grounds for building American policy on the assumption that if the Soviet government believed it enjoyed a sufficient advantage in nuclear weapons to take out American retaliatory power at a blow, it would not do so. Inhibitions may well exist in the Soviet political system against such a course of action…[but] we Americans have no right before man or God to tempt Moscow's planners with this possibility.[1099]

Perhaps Rostow, then at MIT, did not possess the appropriate clearance for the AFTAC briefing or, like many whose government service took them higher up in the bureaucracy, knew nothing of GABRIEL's decade-old findings describing the limits cumulative fallout imposed on war? Whatever the failings of the Soviet system, including the tendency shared with elements in the Pentagon to simply put aside inconvenient science, even when Air Force boosters like Power implied otherwise, the East was governed by the same rules of physics and radiochemistry as in the West. Fallout was an inevitable factor constraining Soviet strategic forces as it was for SAC.

The Pugwash conference process ensured that such concerns were shared between the respective political and military leaderships by top scientists of the Soviet Union, Britain, and the United States, as well as other nations; they met on an annual basis beginning in 1957. Founded by Joseph Rotblat, a close colleague of Bulletin of Atomic Scientists founder and University of Illinois Professor Eugene Rabinowitch, Pugwash's impetus was the call in the Russell-Einstein Manifesto of 7 July 1955 to ban nuclear weapons. Their joint initiative was quite specific in noting one of their motivations was the threat of fallout from thermonuclear weapons.

> It is stated on very good authority that a bomb can be manufactured which will be 2.500 times as powerful as that which destroyed Hiroshima. Such a bomb, if

[1099] "Pay Now: Survive Later," *Air Force*, Vol. 42, No. 12 (December 1959), 9. Having assessed the results of the year that General Power remarked upon as needing a healthy dose of fallout, the *Air Force* editorial board echoed Walt Rostow's own brand of nuclear absolutism by citing him in support of an expansive view of funding needs.

> exploded near the ground or under water, sends radioactive particles into the upper air. They sink gradually and reach the surface of the earth in the form of deadly dust or rain…No one knows how widely such lethal radioactive particles might be diffused, but the best authorities are unanimous in saying that a war with H-bombs might possibly put an end to the human race.[1100]

Thus, the Soviet leadership, as well as the Western nuclear powers, were well aware of the cataclysmic potential of wartime fallout well before 1959, although considerably less well equipped to deliver weapons on the scale than SAC could potentially rain upon the Soviet Union. Only if one assumed that military leaders on both sides were equally dismissive of the threat posed by their fallout to their own peoples could assumptions like those which guided the editors of *Air Force* ring true. Still, this editorial fit a pattern with the worst-case scenario analytical theme the Air Force tended to invoke. By 1959, Eisenhower was largely personally immune to such entreaties, given the availability of significant counter-evidence from U-2 imagery and the AEDS of a substantial American lead in nuclear capabilities. Armoring that was Ike's knowledge there was little to be gained in terms of advantage once the capability to destroy the enemy was in hand, accompanied by more than enough fallout to poison one's own people. While the American public knew little about the strength of Soviet forces beyond the periodic and rather selective State Department denunciations of Soviet testing or about the stark limits fallout placed on the use of nuclear weapons in war, their naivety sustained by secrecy about fallout could be exploited to support assertions like those of *Air Force* magazine's editorial board.

As the Sixties dawned, the AEDS served less well in addressing such factors as the scope of deterrence once significant discrepancies between national intelligence estimates derived from AEDS data and the empty airfields and missing launch sites depicted in U-2 imagery were resolved by CORONA imagery that provided a more accurate assessment of the stark limitations of Soviet strategic forces. The U-2 imagery's lifting of ambiguity about the Soviet threat posture acted to put the brakes on an impressive decade-long run of Air Force budget and funding success. Power's location of the Air Force's vitality as embodied in fallout could simply have been his impassioned observation. However, it may be more accurate to assess Power's

[1100] Michael F. L'Annunziata, *Radioactivity: Introduction and History* (Oxford: Elsevier, 2007), 248-252. The University of Illinois Archives hold a large collection of Eugene Rabinowitch's papers, including extensive correspondence with Joseph Rotblat and others involved in organizing the early Pugwash conferences. Pugwash served as a "backchannel" for scientists from the East and West to continue conversations their respective national leaders found difficulty sustaining at the height of the Cold War confrontation. Others of relevance here among roughly two dozen attendees were several top Soviet scientists, Australian Mark Oliphant, and Walter Selove (who served as a JCAE consultant.)

statement as a call to action to recapture a dependable source that had long proved effective in meeting the service's needs.

Beyond the political uses of fallout, the AEDS provided relatively little new weapons intelligence so long as the Soviets continued with their test halt. The U-2, Air Weather Service aircraft, and stratospheric balloons continued to fly and gather samples that captured significant scientific data on the results from previous testing. This interlude provided an opportunity for assessment of how quickly the atmosphere cleansed itself and additional leads to where and how quickly fallout went as it underwent weathering and decay in the environment.

A contentious difference in goals was at the core of Eisenhower's fears about the pace and scope of the arms race. Evidence here indicated that fallout served as a substantial and growing aggravation of Eisenhower's already deep-seated concerns stemming from his fundamental fear of surprise attack expressed several years prior to his "cross of iron" speech in the spring of 1953 after the 1951 sessions with Oppenheimer and the others working on VISTA. It also imposed a substantive limit on the employment of both strategic and tactical nuclear forces. The Air Force position remained, as Power argued, that fallout was at best a minor concern when so much else was put at stake by the existence of thermonuclear weapons. Limits were irrelevant so long as there was a war to be won. Arguably, the tone of Eisenhower's more sharply critical speech on the threat posed by the military-industrial-scientific-intelligence complex (as described per Greene) delivered as his farewell to government service was framed in considerable part by fallout's frustration of his ability as commander-in-chief to untie the strategic Gordian knot of nuclear weapons.[1101] Even with substantial adjustments in war planning, including enactment of the first joint services war plan, SIOP-62, and the inclusion of a wide variety of relatively low-yield tactical nuclear weapons, fallout's disruption of the initial promise of his effort to forge a more affordable New Look military based on massive retaliation left him grasping for peace after two terms in office, unable to rely on either the thermonuclear weapons that dictated the first strategic military realignment of the nuclear era just eight years earlier or the tactical weapons that Air Force leaders like LeMay and Power still found inadequate to the task.

[1101] Benjamin Greene argued it was more accurate to use the longer term to locate Ike's concerns more precisely. This project is illustrative of taking that formulation to heart by documenting the complex interplay of these institutions and individuals and their effect on the policy making process.

Thus, while only infrequently attributed to concerns about fallout, the Air Force's well-documented concerns about the impact of the test ban on development of new weapons was likely matched by secret concerns like those Power expressed over the disconcerting reduction in its take of intelligence data from fallout. Even more curious was the way the Joint Chiefs of Staff, AFTAC's command authority, portrayed this absence of fallout, terming the test ban an "unpoliced moratorium."[1102] The JCS knew this statement was factually inaccurate, but apparently believed it could hold up to public scrutiny because AFTAC and the AEDS were concealed by official secrecy. Most remarkable was how little stock the Pentagon's public statements put in the viability of a test moratorium, while at the same time the very same unit, which reported directly to the Joint Chiefs, was recognized for conducting such work with considerable praise and honor.[1103] Despite arriving at the far end of a decade of stunningly successful scientific intelligence generated by means of the AEDS, powered by literally thousands of samples taken to build a quantifiable case for the costly expansion of SAC, it was still the military's public position that too little was known about the Soviet threat to justify its support for a diplomatic agreement to implement a test ban. While there were certainly areas of ambiguity and uncertainty in the state of knowledge about the threat posed by the Soviet Union, protestations about a lack of clarity in this area appear deliberately deceptive in retrospect in light of AFOAT-1/AFTAC's history of achievement.

Need for Fallout Defines Negotiating Strategy Even as It Reveals Secrets

The American military understood the capabilities of scientific intelligence systems far exceeded those of mere individual human agency, no matter how well-placed an individual spy might be. The United States maintained position the during much of the Geneva talks that physical inspection was a necessary part of a final agreement was directly at odds with American capabilities and experience.[1104] Human inspectors might provide a different range of assessments of Soviet nuclear capabilities than the AEDS, assuming some agreement could be reached with the Russians, but they were unlikely to provide a better overall assessment of Russian strategic forces than already described by the AEDS and the U-2 – and far less than satellites were expected to provide.

[1102] Nalty, *The Air Force and Nuclear Testing*, 4.
[1103] Air Force Outstanding Unit Award, http://www.afpc.af.mil/library/factsheets/factsheet.asp?id=7785. AFOAT-1 and AFTAC shared in ten Outstanding Unit Awards during the Cold War. It was among the first awardees in 1954, picked up another in 1958, and then received eight more between 1961 and 1982.
[1104] Nalty, *The Air Force and Nuclear Testing*, 4.

The Russians stubbornly objected to intrusive methods such as physical inspection for good reason. An inspector could likely provide rather accurate location data, which might then be exploited for targeting purposes, a reasonable assumption of American intent under the circumstances, given the irritations and limitations of PARPRO (Peacetime Airborne Reconnaissance Program); it was not until the advent of the U-2 as a CIA intelligence resource followed by early satellite imagery that the targeting data gap began to be filled in SAC's war plans.[1105] Likewise, between the contingencies of human agents such as Kim Philby and statements regarding Soviet testing from the AEC, the Russians were undoubtedly cognizant of American efforts focused on determining Soviet nuclear capabilities and locating its supporting infrastructure, which they understood to be largely a result of the fallout and seismic signals that escaped from their testing.[1106] The launch of Sputnik made it doubly clear the Soviets, too, were aware the era of closed air space as a means of information denial was drawing to a close. Despite the common claim during the Cold War that an immutable wall prevented knowing the other, the action of parties in both the East and West in generating telltale fallout, while exploiting the fallout of their peers, demonstrated the parties also relied on fallout as a fundamental means to communicate their strategic military capabilities to others. More than anything else, this meant atmospheric testing was, far and away, the greatest intentional source of compromise of nuclear secrets, not human agents. With access to space for capturing comprehensive imagery virtually on the doorstep at the end of the 1950s, conceding the long-standing U.S. demand for physical inspection of Soviet nuclear facilities was a bargaining chip that needed to be used before it lost its value at the negotiating table as the parties to the talks discovered the rich advantages of such a vantage point. The need for physical inspection, a persistent stumbling point when only the AEDS was available to provide intelligence on Soviet strategic forces, withered away with the vastly greater capabilities for targeting and other data

[1105] Walter J. Boyne, "The Early Overflights," *Air Force*, Vol. 84, No. 6 (June 2001), http://www.airforcemag.com/MagazineArchive/Pages/2001/June%202001/0601overfly.aspx. PARPRO relied primarily on aircraft converted to reconnaissance use to conduct flights probing Soviet borders from otherwise virtually identical bomber aircraft used by the U.S. military. Even trained observers were unlikely to be able to distinguish between those gathering intelligence and those which could represent the first wave of an American attack. This was intentional, as the U.S. military wanted to test the reactions of Soviet air defenses to such encounters, collecting the corresponding radio traffic and radar emissions to analyze the effectiveness of these Russian units.

[1106] It was unlikely that the USSR was aware of the MUSIC krypton-85 monitoring program to determine the rate of Soviet plutonium production, as they were from the beginning about the rather obvious fallout monitoring program, with the defection of Kim Philby and periodic announcements of detection of many Soviet test shots by the Americans.

provided by the U-2 and satellites. Thus, while updates of the AEDS substantially improved its capabilities by the end of the Eisenhower administration, the addition of imagery capabilities quickly moved from supplementing the AEDS to become the predominant factor in the production of national intelligence estimates of Soviet strategic capabilities.

Aided by the highly classified nature of the program, the Joint Chiefs of Staff could selectively reveal or obfuscate the actual intelligence capabilities available to the military. Their public claims, and even classified ones such as Power's, strongly suggested any test halt was based on mistaken beliefs about American offensive or intelligence capabilities – or worse, perhaps supported by nothing more than simply trusting the Soviets would not violate it. To imply that nothing more than trust sustained the test moratorium was an obvious attempt to impose political limitations on policy change during an era when McCarthyism remained very much alive. Small wonder their retiring commander called them out as part of the problem of peace, rather than excluding them from his critical summing up before Congress upon his departure from a command he held longer than any other, the presidency.

1959: "…nuclear testing is bad…"

James Killian, the president's Special Assistant for National Security Affairs for arms control and fallout issues, summed up the conundrum in a memorandum later in March 1959 after the president told his advisers that he concluded "nuclear testing is bad." Reflecting this conclusion, Killian clearly identified fallout as at the root of the problem of both developing and using nuclear weapons.

> The overriding technological fact, however, is the continued build-up of improved high-performance nuclear weapons on both sides make possible catastrophic effects if they are used in massive attacks.
>
> Another technological factor involving uncertainties is the problem of fallout. The biological effects of radiation involve uncertainties, particularly in the genetic area, and we may possibly face a growing body of sober scientific judgment that the fallout hazard is greater than we now believe.
>
> The profound over-all effect of these trends points to the great urgency and importance of our diligently and creatively seeking methods of arms limitation – limitation which will not weaken our position relative to the Soviets.[1107]

[1107] James R. Killian, Jr., Memorandum for the President, "Technical Factors Relating to Arms Limitation and to the Geneva Conference on Nuclear Test Cessation," Eisenhower Library, Ann Whitman File, Administration, Box 23, 31 March 1959, 3. This copy of the memo was initialed by the president on the last page, indicating he read it.

While not explicitly mentioned in the first paragraph about the wartime dangers of nuclear weapons, it was no longer 1953, it was 1959 and the cat was out of the bag in terms of public knowledge of fallout being among those dangers; catastrophic weapons effects now clearly included the problems of both prompt and cumulative fallout. That inclusionary meaning was contextualized by the explicit meaning of existing fallout from testing itself Killian sketched as the topic of the second paragraph.

That fallout was at the center of the testing problem in Killian's view was further reinforced by his discussion on how to define the limits of the atmosphere under an atmospheric test ban agreement. Killian argued whatever the definition of tests conducted in space was, it must be undertaken far enough away to preclude their fallout from returning to Earth. In terms of moving the policy argument forward, Killian noted the need to revise an American priority: any agreement must be capable of being effectively monitored, a somewhat different formulation of the earlier "subject to inspection" mandate. Killian's reformulation of the inspection problem was dependent on capabilities that up to this point were almost exclusively intelligence activities of the most exquisite sensitivity.

While surprisingly disclaiming any priority for "…technical factors [that] probably are of secondary importance to political or policy objectives…" Killian's memo did not merely fall on fertile ground, but as pollen on a fertile policy field that was at that moment being forced to conclusively reevaluate erroneous assumptions about the military utility of nuclear weapons in light of the contingency of fallout.[1108] Killian may not have explicitly mentioned fallout in terms of the "catastrophic effects" of nuclear war, but it was clear from the government's own post-CASTLE BRAVO reports that the combination of acute local and cumulative global fallout in most nuclear war scenarios would far exceed the parameters of risk defined by Project GABRIEL. The fear of fallout from testing Killian related indicated even detection of low level fallout in the food supply was seen as imminently threatening, even as it strongly suggested worse was to come.[1109] For the president, Killian offered substantive, articulable and cogent narrative and commentary reinforcing his own much longer view of the situation.

[1108] James R. Killian, Jr., Memorandum for the President, "Technical Factors Relating to Arms Limitation and to the Geneva Conference on Nuclear Test Cessation," Eisenhower Library, Ann Whitman File, Administration, Box 23, 31 March 1959.

[1109] Killian chaired Eisenhower's initial 1953 committee studying the problem of surprise attack, as well as serving as president of MIT. When PSAC was formed, Killian was a natural fit.

Where they differed was on the question of the reliability of seismic detection, which Killian concluded was not absolute, siding with the Pentagon and AEC Chair John McCone on continuing underground testing. Eisenhower took the more practical approach that cheaters would eventually be caught and relatively little was left to learn of importance through testing anyway. Eisenhower understood the AEDS did not have to be 100% accurate so long as the vast bulk of nuclear events were recorded.[1110] Strikingly, in the decades since, Eisenhower's pragmatic view has been largely eclipsed by the military's argument that technology that served well for intelligence purposes arms must, once converted to arms control verification purposes, be unfailingly accurate.

<u>1959</u>: Limiting the Political Threat Posed by Fallout

Given the continuing disappointing results of testing "clean" designs at HARDTACK, it was not surprising that afterwards the military insisted on portraying fallout primarily as a problematic technical issue that must be accepted in a world where nuclear weapons existed, rather than as a problem worth spending additional effort and expense to pursue a solution. Such a conclusion fit with seeing deterrence as an ameliorative policy frame that seductively suggested the same weapons said to prevent nuclear war could also be counted upon to prevent fallout, too. The primary attractive feature of the appeal of using arms control as a justification to end atmospheric testing, rather than framing an agreement as being necessary to end fallout, was that it provided an alternative justification that avoided bringing into question the entire nuclear enterprise. Moreover, the term "arms control" was politically useful since it suggested humans were in charge and able to safely manage nuclear power, even as fallout was clearly one aspect of nuclear weapons at direct odds with the notion of their control by humans. Ending fallout for this reason served to avoid laying blame on the weapons and the decisions made by the all too human military and civilian managers who created them. Likewise, the term "arms control" suggested it was a measure to prevent fallout from a future war, when in fact a test ban agreement was at least as much a decision to end an ongoing substantive risk created by fallout from past and current testing.

Fallout's role in the Pentagon's suddenly acceding to an end to atmospheric testing was a position forced upon the military by circumstances, not choice, by data, not emotion. Potential military support for an end to testing also addressed increasing concern about the risks posed by

[1110] Greene, *Eisenhower, Science Advice*, 186-197.

fallout, only became a distinct possibility once the problem of the accelerated deposition return rate from the upper air was identified. Initiating CROWFLIGHT to gather better data was one response to this problem, so the issue arose irreconcilably at some time prior to mid-1957, motivated by the high deposition rates typical of spring. The data was thus based on testing in 1956 and before.[1111] By appearing to address public concerns, if only indirectly and at a snail's pace, the government's cat and mouse relationship with fallout embraced the concept of using arms control as the justification for a test halt agreement. While fallout was not specifically mentioned, an omission that should now seem both pro forma and more telling than not to readers, there was considerable discussion about the status of the negotiations in Geneva; confirmation from Secretary of Defense Gates that "all the people , both in the Defense Department and in the Congress who have to deal with defense, are fully convinced of our relative military superiority;" and Eisenhower himself "pointed out that the great problem is keeping a big war from starting."[1112]

The dog-and-pony show before Congress in the 1959 fallout hearings seemed primarily intended to reassure the public an end to atmospheric testing should not imply fallout was a threat or that it imposed limitations on the use of nuclear weapons.[1113] The AEC's reframing of actions taken to reduce the risks of fallout claimed they were prompted by an abundance of caution in order to more safely test weapons. Such a position reflected a revision of the government's previous assertions it paid close attention to the risks posed by fallout, despite an at best spotty record, lack of institutional control and oversight, as well as limited evidence the AEC managed this risk effectively in the public interest. Only because of the secrecy associated with AFOAT-1 and its mission did the rather obvious conflict of interest involved in permitting

[1111] Given the warning order for the 4080th SRW(L) regarding CROWFLIGHT was dated 11 October 1957, this suggests a date no later than roughly mid-summer 1957 as the time when it was realized fallout was problematic and would require further investigation. Since the return of stratospheric fallout was heaviest in the spring, it is most likely that the results of spring 1957 forced this hand on the government, pointing toward testing during 1956 and before as the culprit in creating enough fallout to finally get the attention of the government.

[1112] "Informal List of Subjects to be Discussed at Meeting of President Eisenhower and Senator John F. Kennedy." undated; John H. Sharon and George W. Ball to Senator John F. Kennedy, "Memorandum: Meeting with President Eisenhower," 5 December 1960; "Briefing Memoranda for Meeting with President Eisenhower, Tuesday, December 6, 1960," 5 December 1960; John F. Kennedy Library, Pre-Presidential Files. Wilton B. Persons, "Memorandum for the Record: Meeting in the Cabinet Room with the President and President-elect Kennedy," 6 December 1960, Eisenhower Library, Ann Whitman File, Presidential Transition, Box 1.

[1113] By the time of the fallout hearings in May 1959, Eisenhower had already ruled out further atmospheric testing during his presidency. It was uncertain how widely shared this was, but may have been a point of concern in the background during these hearings.

the part of the Pentagon with the most skin in the fight over fallout, the Air Force, determine research access to fallout data go unnoticed.

<u>1959</u>: Year of Continuity and Change at AFTAC

1959 was the end of an era in another way, when AFOAT-1 formally stood down that July and a new unit was established, Air Force Technical Applications Center or AFTAC, an ambiguous and not very informative designation the unit continues to employ to this day. The ambiguity of the title was likely intentional, saying as little as possible about what its mission actually was. In 1959, the entire enterprise remained highly classified, so the parent organization again adopted a dual-identity, with the 1035th Field Activities Group (1035th FAG – an acronym that in the context of a profoundly homophobic federal government of that era suggested it was chosen as unlikely to be carelessly repeated in casual conversation) replacing the 1009th Special Weapons Squadron as the cover military unit designation did for AFOAT-1. The system of intentionally deceptive double unit designations persisted in multiple iterations until 1980, when the last of these parallel organizations, the 1035th Technical Operations Group, was folded into AFTAC as its Headquarters section.[1114] By redesignating the unit from AFOAT-1 to AFTAC in July 1959, the Air Force seemed to want a clean break with the unit's top secret past dedicated solely to intelligence, given the fraught role of fallout as a very public problem, no longer capable of concealment as one of the deepest of state secrets.[1115]

Covering the year of the unit's redesignation, 1959, AFTAC's first post-AFOAT-1 history told a somewhat unconvincing tale, given multiple similar earlier compromises, some cited herein, provoked no earlier name change. Given the restrictions in place on use of identifying information and multiple identities, the argument that several recent news articles

---

[1114] AFTAC, *A 50 Year Commemorative History*, 5-6, 139-141. No significant releases of historical materials from AFOAT-1/AFTAC occurred until 1997. In celebration of the fiftieth anniversary of the unit's founding, the *50 Year Commemorative History* was published. While short on many details, the vagueness of the monograph provided a handy reference for those in some way connected to the organization to point to as to what had been declassified, a sort of informal RDD (Restricted Data Declassification Guide, a handbook that was published and regularly updated by the AEC and Energy departments of which nuclear secrets had been declassified) for nuclear intelligence. If it was in the book, those facts were no longer secret and could be addressed to the extent they were covered in the book. This seemed intended to limit such conversations strictly to what was compiled in the book.

[1115] Richelson, *Spying on the Bomb*, 126. Richelson cited news account of a far too specific presidential award given to Doyle Northrup, AFOAT-1's Technical Director, as the precipitating reason for the name change, but then recounts somewhat ambiguously how it was an unlikely solution, given the Pentagon telephone directly simply changed the listing after Northrup's name from AFOAT-1 to AFTAC. As with many narratives that superficially seem to fit, but which seem eclipsed by circumstances once examined further, publicity about Northrup's award seems an insufficiently explanatory reason for the change.

necessitated the change for security purposes was not entirely persuasive.[1116] Isolated cases largely without context, it was unlikely anyone without the proper clearances to understand their significance learned much of significance. Tight information control about the unit largely prevented the press or public from cognizance of the context, extent, and capabilities of nuclear intelligence operations in assessing what little information escaped the otherwise hermetically-sealed chamber enclosing AFTAC.

<u>1960</u>: The Democrats and Fallout

For Democrats, fallout policy in the second Eisenhower administration was more complex and contradictory, alternating between one-upping Eisenhower as too weak on national security; raising concerns over the health risks posed by fallout as Adlai Stevenson II did in the 1956 campaign versus Eisenhower; using it as an aggravating factor to foster the unsubstantiated growth of belief in both the bomber and missile "gaps;" and as a threat to their abiding fascination with the use of military spending as economic policy. Many grew increasingly cautious about the problem of fallout. Among the Democrats on the forks of this nuclear dilemma was Senator John F. Kennedy of Massachusetts. Kennedy's pre-presidential papers contained Democratic Party research on what it saw as the Eisenhower administration's blithe dismissal of the implications of Sputnik, symbolic of what they saw as the technological lag caused by Eisenhower's economies of government, which the Democrats argued was an inherent cause of the "gaps" instead of inaccurate spin the Air Force put on its selective release of classified intelligence information. Headlines in the *Democratic Fact Sheet,* produced by the national party's research division, quoted Eisenhower saying the Soviet satellite did not "bother me 'one iota.'"[1117] The next edition of the *Fact Sheet* was chock full of items, the leading wave of a Democratic theme that bore the political sticks and stones Eisenhower faced in his last two years in office – and which Richard Nixon confronted in his ill-fated 1960 campaign. While

---

[1116] AFTAC, 1959 Unit History, 41-42; AFTAC, *A 50 Year Commemorative History*, 41. The security compromises involved the White House, when Doyle Northrup received the President's Award for Distinguished Civilian Service with a far too specific citation of his service; a Defense official who referred the *New York Times* to Northrup in reference to a report on seismic system improvements; an aggressive reporter for Newsweek who linked AFTAC and Project VELA (the overall program to improve the AEDS in anticipation of the need for increased verification capabilities following a partial test ban); and a magazine article (not specifically cited) that revealed the 56th Weather Reconnaissance Squadron, based in Japan, conducted air sampling , given the Japanese government had not previously been informed about the practice. Fatzinger's focus on the identification of Northrup hardly seemed to be the sensitive matter to spark such a change. Northrup gave "expert scientific testimony" at a "Conference of Experts" in the summer of 1958 in Geneva where his Soviet counterparts were also participants.

[1117] *Democratic Fact Sheet* (Washington, DC: Research Division, Democratic National Committee), 10 October 1957, Kennedy Archive, Pre-Presidential Files, 1957.

other quotes addressed the need for American engagement in the scientific struggle that resulted in humans walking the Moon before the next decade ended, the main thrust of informed opinion the Democratic Party sought to exploit was that Sputnik was an American military defeat.[1118] Fortunately, the future president was, like Eisenhower, a leader who valued thoughtful advice as an essential element of the policy-making process. After the initial national security transition briefings, Kennedy's priorities changed and the "gaps" quickly disappeared from the political narrative. Fallout did not.

1960: Defining the End Game

The 1960 presidential campaign pitted John F. Kennedy against Eisenhower's vice-president, Richard M. Nixon, in a down-to-the-wire contest where Kennedy prevailed. The victorious Democrat's campaign hammered at supposed Republican fostering of military weakness by repeated references to the bomber and missile "gaps" in a political space ripe to foster nuclear belligerence – except for the persistent, intruding presence of fallout.

Historians noted Eisenhower keenly passed on to John F. Kennedy the information refuting the existence of the bomber and missile gaps during the presidential transition; the thirty-fifth president immediately ceased flogging them as issues and moved on to confront the even more grim realities passed on by his predecessor.[1119] As with much else of its history, extant documentation left it uncertain if Ike took the time to fully explain the historical complexities of fallout as a problem, which backed him into the corner he found himself in with nuclear weapons as commander-in-chief. Certainly the test moratorium was among topics

[1118] *Democratic Fact Sheet* (Washington, DC: Research Division, Democratic National Committee), 1 November 1957, Kennedy Archive, Pre-Presidential Files, 1957. Among these were:
"Come Off It, Ike, Who Are You Kidding?," *Denver Post*
"Eisenhower Comments 'Frivolous in Their Inadequacy," *Sacramento Bee*
"Eisenhower Reassurances 'Not Very Reassuring," *Washington Post*
"Smugness…in the Official Attitude toward Defense," *Philadelphia Inquirer*
"A Compound of Errors Caused Our Defeat in the Satellite Race," *New York Times*
"Why Hasn't Congress Been Informed?" *Richmond News Leader*
"It's Time Eisenhower Told Us the Truth," *New Orleans Item*
"What the Nation Is Getting Is a Cover-Up," *New York Herald Tribune*
"Eisenhower Shows 'No Disposition to Do Anything but Talk," *Louisville Courier-Journal*

[1119] "Memorandum for the Record: Meeting in the Cabinet Room with the President and President-elect Kennedy," 6 December 1960, Eisenhower Library, Ann Whitman File, Presidential Transition, Box 1.In a 6 December 1960 transition meeting, Defense Secretary Gates made of point of noting the advent of the first SIOP and assured Kennedy everyone involved in Defense, in his department and in Congress "are fully convinced of our relative military superiority." Gates seemed intent on communicating that any weakness the president-elect might perceive among American forces, given the tenor of the recent campaign, was something the military had already taken pains to address.

discussed between the two leaders, still in place but teetering after the U-2 shootdown in May 1960. However, there can be little doubt Eisenhower made it clear to Kennedy fallout's threat motivated his decision to maintain the moratorium; thus, Eisenhower handed off this radioactively "hot" potato of a largely implicit, ad hoc, and "in effect" fallout policy to his successor with a clear conscience. Having learned the difficult ropes of state armed with his considerable experience as a general, the lesson of fallout's significance in its central role in the Cold War to that point made it an essential topic in meeting Ike's need to fully brief the junior officer that succeeded him on the most important of his lessons learned about nuclear weapons.

By now familiar with the effectiveness of the AEDS network to provide reliable global detection of fallout and other significant phenomenon, toward the end of his second term Eisenhower chose to open the door to using the well-worn, tested tools provided by fallout for a different purpose – verifying a nuclear arms control regime. Besides reflecting in his valedictorian speech on the perils of the military-industrial-scientific-technological complex, as Benjamin Greene more accurately described the multilayered subject of his frustrations and cautions, Eisenhower later described the failure to conclude a test ban treaty as the greatest regret of his presidency.[1120] In essence, after the dust of fallout settled, Eisenhower ended up back at the same place that Vannevar Bush and Oppenheimer arrived at in 1952 before IVY MIKE, except with much more fallout. These and other factors point toward Eisenhower making sure the ball was not dropped on fallout in the transition, despite it not being listed separately from the topic of disarmament and the test ban negotiations. Fallout was clearly unfinished business, a perplexing problem which every president since has likewise left to those who follow. In 1961, it was important enough that a successor needed to be aware of it as he prepared to live with the nuclear "button" in the White House. Fallout taught a fundamental lesson in presidential power and its limits that even a sharp character like Eisenhower found required most of his presidency to understand. Knowing the arsenals of both East and West were fully stocked, Eisenhower likely emphasized to Kennedy that he would not have the relative luxury of time, distance, or military advantage he enjoyed during most of his two terms in office. Fallout was far from resolved, as Khrushchev soon made clear.

[1120] Greene, *Eisenhower, Science Advice*, 1-8; Glenn Seaborg, *Kennedy, Khrushchev and the Test Ban* (Berkeley: University of California Press, 1981), (citing Herbert York), 10.

Without a formal agreement in place to end fallout, at the end of Eisenhower's second term the unilateral moratoriums initiated by the Soviet Union, United Kingdom, and United States remained precariously in place, with negotiations on a comprehensive test ban and related matters largely frozen by the corrosive effects of the May 1960 shootdown of F.G. Powers' U-2. World weariness with fallout documented in great detail by the existing historiographic focus on the social and cultural boundaries made and broken by fallout and the simple fact that the 1963 Limited Test Ban Treaty was signed and ratified despite the brief, crisis-laden span of Kennedy's presidency demonstrated fallout was a pivotal sticking point in political and military strategy of the early Cold War. The Bay of Pigs, Berlin, and the Cuban missile crisis – the superpower confrontation brought East and West to rhetorical blows, backed by their respective thermonuclear arsenals, but the next-to-warring parties nonetheless pursued a consensus to end fallout, at least for cases short of war. By 1961, fallout was a telling portent of the necessity of the nuclear superpowers avoiding war, still successfully, if you are reading this now rather than burning it to keep warm through some long, post-attack winter of discontent in the future.

However clear-cut the issues may have seemed at the transition from Eisenhower to Kennedy in 1961, the 1963 agreement came at a price – a veritable deluge of more fallout than ever generated before as the Soviet Union engaged in a series of high-yield tests that matched or exceeded the U.S. Air Force's own ambitions for such weaponry. With the "tsar bomb" (~56 megatons, 30 October 1961) just the mightiest among those forming a veritable fallout flood from Soviet testing, the USSR deployed as harsh and damaging a weapon of diplomacy ever used short of war itself.[1121] Paradoxically, during crisis after crisis in Kennedy's short term in office, fallout's deterrent effect also contributed to human survival. Diplomatic engagement at Geneva on the test ban negotiations, along with exchanges between scientists facilitated by

[1121] AFTAC, 1961 Unit History, 35-43; David A. Fulghum, "USAF Reconnaissance Comes into Focus," *Aviation Week and Space Technology*, 24 July 2000, 184. AFTAC, alerted by declared Soviet intentions, arranged with a secret Air Force unit specializing in converting aircraft for unprecedented intelligence collection missions, BIG SAFARI, to hastily modify a RC-135 to collect data on the Tsar Bomb's test. Code-named Project SPEED LIGHT, the conversion was the first in what became a long, diverse line of RC-135 intelligence and surveillance aircraft based on the KC-135 airframe that continue serving with the Air Force. To monitor the test near remote Novaya Zemlya required a platform with extreme range and a high payload capacity. The aircraft successfully collected its data and returned to base, despite getting close enough to the test shot that the aircraft's paint was scorched by the thermal pulse of the explosion. Instruments to measure "geophysical disturbances" were installed aboard the plane along with an extensive suite of electromagnetic detection instruments, a bhangmeter, and photographic equipment, much of it installed in a unique hump on top of the fuselage. The success of the mission drew a letter of appreciation from President Kennedy.

Pugwash, led to both East and West understanding fallout that nuclear war would only yield losers: belief that a nuclear war could be "won" was obvious hubris.

<u>1961</u>: Science, Health, and Politics of I-131 and Milk

The critical role of iodine-131 as the primary immediate health threat posed by local and regional fallout has been examined at length previously, although its connection to nuclear intelligence has received remarkably little notice.[1122] Following the 1957 Windscale plutonium reactor fire, milk attracted considerable public interest and research attention as fallout was recognized from that point forward as finding its way quickly and insidiously into this intimate object of consumption, becoming a tipping point for policy change with special resonance for women and families with children.[1123] In a memo dated 20 June 1962, Jerry Wiesner, Kennedy's science advisor, briefed the President on the especially problematic nature of iodine-131 in the heavy fallout then underway from the relapse to atmospheric testing. [1124] The crisis over iodine-131 levels in milk arose due to the sharply spiking overall total volumes of fresh fallout, with roughly 80% of it contributed by the larger Soviet tests, accompanied by smaller amounts of fallout from U.S. tests after testing resumed in April 1962. Wiesner observed the milksheds of several communities known to be most affected (Minneapolis, Des Moines, and Kansas City) by the intensified fallout deposition described by Machta and List would not pass what the Federal

---

1122 Cross, *Fallout*. The Windscale accident is fairly well-documented. Cross' very accessible narrative involved the documentation of widespread iodine-131contamination from British testing in Australia in the years just before that accident made the isotope more familiar to the world. But Cross' example of a single provincial scientist, Hedley Marston, unraveling one of the more sensitive secrets of nuclear intelligence was illustrative of the problem of continuing to rely on atmospheric testing as the pool of scientists and equipment capable of discerning fallout's spread grew exponentially with Eisenhower's Atoms for Peace program.

1123 Divine, *Blowing on the Wind*, 262-269. Divine assessed the impact of the 1959 hearings and the associated AEC releases of revised estimates of rapid fallout return as leaving "the American people in the grip of a full-scale radiation scare." One letter from a fearful mother published in the *New York Times* that Divine cited observed "a nuclear attack is an uncertainty, even an improbability; the peril of increasing fallout is a dead certainty." Divine's take on this was that "The loud outcry over fallout forced the Eisenhower administration to take steps to reassure the American people." Yet as is now clear, public pressure was only one factor, matched at least equally by secret data that ratified those concerns, despite the denial of its significance by Libby and the AEC.

1124 Richard L. Garwin, "Pugwash at 50: Much to Do and How to Do it," Address at 14th Student Pugwash, 2007, http://fas.org/rlg/041407PUGW2.pdf; Judy Rosenblith, ed., *Jerry Wiesner, Scientist, Statesman, Humanist: Memories and Memoirs* (Boston: MIT Press, 2003). Wiesner was an early participant in the Pugwash movement and thus acquainted with Mark Oliphant, who urged Hedley Marston to pursue his iodine-131 research as well as earlier urging Frisch and Peierls to publish the first calculations of a critical mass reaction. Likewise, Wiesner advised Dwight Eisenhower on the same issues prior to taking a leadership policy role under Kennedy, so represented an important strand of continuity in presidential arms control policy making during the time when fallout was a central preoccupation. Although any direct connections that may be possible to draw here between them and the Hedley Marston affair in Australia awaits further research, it is important to note the relatively small world in which ideas about fallout and its threat circulated, as well as to honor those involved in the heavy lifting leading to a step back from the brink of nuclear disaster through the pursuit of arms control.

Radiation Council (FRC) called a "guide level" for fallout levels present, somewhat disingenuously blaming Soviet nuclear profligacy as the root of the problem. The milk exposure levels were set by the FRC in 1961 based on limits it then paradoxically claimed were unsuitable as a food standard in 1962 because they were intended for industrial work.[1125] The U.S. Public Health Service argued if additional fallout pushed the exposures over the limit, counter-measures should be taken, such as switching to stored feed for dairy cows or feeding children only with powdered or other processed milk with enough lag time since processing and storage allowed enough time to pass for any iodine-131 present in it to decay to safe levels.[1126] The U.S. government was effectively stuck between mostly Soviet fallout bringing iodine-131 to dairy grazing land and the U.S. government's own standards of what was considered a safe level.

Despite the risks, Kennedy officially set in motion the effort to undertake the last few atmospheric tests at NTS, as well as SEDAN's ultimately rather dirty "underground" shot, but withheld final approval for what became the last U.S. atmospheric test, LITTLE FELLER I, the Davy Crockett troop maneuver test shot.[1127] The relatively careful pace of American testing that remained within the same order of magnitude as originally suggested by GABRIEL served to cushion the impact of this issue from rising into widespread public awareness, because unlike with the CASTLE BRAVO incident, there was no dramatic association between a problem and its cause with fallout from NTS after its early years.[1128] The American effort to minimize test fallout so as to limit public concerns to the extent possible stood in dramatic contrast to the 1961-

[1125] Federal Radiation Council, memo summary accompanying "Health Implications of Fallout from Nuclear Weapons Testing through 1961," Kennedy Library, Office of Science and Technology, Box 42. This explanation appears facetious, given the FRC was established by Eisenhower precisely to avoid these conflicts over the interpretation of exposure standards, which previously arose with strontium-90 levels in wheat recounted earlier. A memo from early May 1962 discussed that the lower exposures required under occupational exposure guidelines were considered to be for the sort of long term low level found at job sites. While excluded as a wartime effect, fallout was specifically addressed in the formulation of the exposure guidelines. Since fallout was a wartime effect, "the question was asked facetiously – "How can one control fallout?" Thus they considered the question of fallout as one of exposure to it under conditions other than those of "normal peacetime operations," which they apparently believed to be intermittent and periodic rather than daily as it was on the job. For the FRC, fallout was indeed a wartime effect in peacetime as they defined it. Given the average workweek was forty hours and fallout worked around the clock, it was a somewhat unconvincing reason.

[1126] Jerome Wiesner, Memo for the President "Background Information on I-131 Levels Present in Fallout," 20 June 1962, Kennedy Library, National Security Files, Subjects, Nuclear Weapons Testing, General, 4/5/62 – 7/30/62, Box 300.

[1127] McGeorge Bundy, "Memorandum of the President's Decisions at the Meeting on Nuclear Tests on June 20, 1962," Kennedy Library, National Security Files, Subjects, Nuclear Weapons testing, General, 4/5/62-7/30/62, 22 June 1962, Box 300.

[1128] Some livestock were affected by beta burns and other fallout effects in early testing, but increasing cautions with yield after 1954 avoided any further incidents of widespread notoriety. SOCORRO (6 kilotons, 22 October 1958) was the highest yield atmospheric shot after HOOD (74 kilotons, 4 July 1957), the record high yield shot at NTS.

1962 Russian test campaign, which dropped any pretense of carefully controlled nuclear weapons without consequence, creating a policy crisis that forced the fallout issue onto the table. Placing the blame for the larger amount of fallout on the Soviets failed to reassure consumers. The problem was that Americans generally saw any amount of I-131 in milk as detrimental to health, no matter what its source. With state authorities closing milksheds over the high readings per previously agreed protocols, pressure to act on atmospheric testing peaked at the White House, just as it had with strontium levels in wheat under Eisenhower in 1959.[1129] Cumulative fallout proved to be a problem, not only as theorized with general nuclear war, but even with the far more limited fallout from testing.

<u>1961</u>: Back to a Future of Fallout

In addition to suspicions it could be used to evade detection, it was understood testing in space could contribute to threatening global fallout deposition rates unless detonated well beyond the atmosphere.

> Out-of-Atmosphere Testing
>
> Objective – Capability of (1) testing large yield weapons with reduced fallout in the event surface testing is not authorized; (2) testing large yield weapons in the event unacceptable atmospheric contamination is reached by the United States and/or Russian surface tests…[1130]

Notably absent from the list of possible motivations for such a technologically challenging testing solution was any reference to subjective forces such as public opinion or political pressure. The term "unacceptable atmospheric contamination" could be read as entirely anticipatory, but given the effort to document existing fallout then underway, the need for potential atmospheric testing to be avoided entirely suggested further significant testing would push existing levels of fallout rather quickly towards unacceptable levels.

Planning for the 1962 DOMINIC test series continued a trend of increasing restrictions on testing itself that began during the first post-CASTLE series tests, the 1955 TEAPOT series at NTS, but which was now clearly in reaction to the empirical threat of cumulative fallout.

> Even in this new series, as in HARDTACK, total fission yield would be limited to minimize worldwide radioactive fallout. All weapon development tests would be fired as medium-altitude airbursts to keep fireballs from reaching the surface,

[1129] See 369-371 for Eisenhower's reaction to the wheat contamination in Minnesota.

[1130] Hansen, *Swords of Armageddon*, IV-390. Quote drawn from an emergency plan to restore testing infrastructure by Sandia Corporation, "A Plan for Establishing a Capability for Large Yield Testing in Two Months."

> further minimizing fallout… The fission yield fraction of [at least one high-altitude shot] shot would also have to be minimized.[1131]

Here, too, was another irony in Wiesner's memo arguing it was bad Soviet fallout, not good American fallout, which would push iodine-131 in Midwest milksheds past the FRC's 1961 guidelines. While the United States was taking great pains to reduce fallout from testing itself and in a limited number of its new "clean" designs, this did not address the fundamental problem of the threat posed by the cumulative wartime fallout if SAC's war plans were carried out. On the other hand, given the stark realities of wartime fallout, the cavalier, promiscuous Soviet approach to testing and the resulting over-the-top yields was also a fundamentally honest one, for all its rough edges.

How close the resulting fallout from all parties pushed global fallout deposition toward the levels GABRIEL predicted as problematic remains a question the Air Force has the best answer for. Given the known yields, the testing trends and the subsequent troubling record of longer half-lived isotopes mapped out in everything from reindeer meat to the lead that AFTAC used to shield its more sensitive instruments, if the data was exculpatory about the risks posed by shorter half-lived isotopes in fallout, particularly iodine-131, significant portions of it would most likely have been declassified.[1132] The wall of silence on this matter will have to continue to speak for itself, but now it will be a silence informed by basic knowledge of the context and circumstances about how and why basic information on the circulation and potential deposition of the most damaging isotopes found in fallout remains off-limits to researchers.

Lurking just off-shore in the Pacific as the American test series was conducted at the British possession, Christmas Island, in 1962 was another reason why fallout was increasingly problematic, even for the military – a small fleet of Soviet intelligence vessels, led by a 3,600 ton research vessel equipped with sixteen laboratories.[1133] The effort was not new, but the scope of it

---

[1131] Hansen, *Swords of Armageddon*, IV-396.

[1132] Soviet fallout from testing on Novaya Zemlya was largely responsible for increased concentrations of radiation in reindeer meat consumed by aboriginals and others in the northern latitudes. A number of studies associated with the study of cesium-137 contamination in reindeer in Scandinavia that originated to study Cold War era fallout required grim follow-up after the 1986 Chernobyl accident dumped more radiation in the region. AFOAT-1/AFTAC used lead shielding to permit more precise measurement of radiologically-suspect samples. This method first found success with the "wrap-around" counter used to evaluate the samples proving Joe-1's detonation in 1949. To avoid contamination in lead smelted after 1945 by atmospheric shots from testing and war, old lead sewer pipes are processed under clean conditions to provide lead uncontaminated by fallout.

[1133] Hansen, *Swords of Armageddon*, IV-445. In part due to the high yields of testing thermonuclear weapons, but also because of Hedley Marston's efforts to publicize iodine-131 contamination from testing in Australia, the British was; the obvious Soviet presence suggested a turning of the tables on nuclear intelligence, as well as represented a thorny political problem. The Soviet trawlers and their headquarters ship made clear what a relatively small group within the government always knew – testing in the atmosphere was a sure way to give away your secrets.

1962: Nuclear Absolutism

On 23 July 1962, the Joint Committee on Atomic Energy (JCAE) heard testimony about the U.S. position at Geneva. William C. Foster, Director of the U.S. Arms Control and Disarmament Agency, testified, as did a number of other officials involved in arms control and nuclear intelligence efforts, including Doyle Northrup, the Technical Director of AFTAC. The committee was concerned disputes similar to those centered around the seismic capabilities in the 1958 test ban proposal due to belated assessment of the results of the 1957 RAINIER test did not recur at Geneva. At the same time JCAE Chair Representative Chet Holifield (D-CA) worried the U.S. was "too eager to make concessions in order to give the appearance of progress in terms of world opinion."[1134] The political fears surrounding the issue were bipartisan, as stated by Representative Craig Hosmer (R-CA), who reminded again of how ignorance generated misgivings about arms control measures in Congress, "I am unhappy with [the] State Department and your preoccupation with the opinion of other nations around the world."[1135] Hosmer disclaimed any "demand for a 'foolproof' treaty," yet his formulation clearly called for assurances that would be technically, if not politically impossible to deliver.[1136] Despite the insistence the United States should ignore the influence of transnational public opinion, the repeated calls to disregard it demonstrated how fallout's continuing generation of these public pressures created a dynamic that could only be addressed by ending the production of fallout from testing. However, these political disclaimers served to provide cover for why the government found motivation to end fallout by constructing the pretense that public opinion alone was the driving force behind pressures to eliminate fallout. Largely a parade of witnesses

---

moved their tests to Christmas Island after their 1957 test series in their former colony. Subsequently, in exchange for use of the island's facilities for United States tests, the United Kingdom gained access to test underground in Nevada at NTS.

[1134] Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," [Note: typed date of 29 July was corrected by pen to 23 July], Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 4.

[1135] Ibid, 70.

[1136] Craig Hosmer, "The Test Ban: 'Safe & Unsafe' Positions, Seismology, Scylla's Sirens," Text of author's remarks to be delivered on 31 July 1962, JFK Library, National Security Files, Box 300. Text was one of a number of communications to the press and to the White House from Hosmer found in these White House files.

offering reassurance of the relatively innocuous nature of testing fallout, the hearing emphasized the relatively benign nature of nuclear weapons.

The JCAE hearing was considered secret because it discussed the U.S. negotiating strategy for the talks in Geneva, not because those present discussed classified information on weapons or intelligence. Foster specifically noted that it should be classified as "Limited Official Use" solely because of the need to avoid disclosure of the U.S. negotiating position.[1137] Yet the hearing transcript was another example of the persistent habit of over-classifying national security information, since it was subsequently classified as Restricted Data. Even after declassification in May 2009, several excisions remained in place, a typical situation facing historians pursuing a more comprehensive history of arms control. The primary concern at the time focused on the administration's witnesses' recounting of alternatives to move the Geneva process ahead, including the position eventually adopted that ended all but underground testing.

Under discussion was the Defense Department's recent announcement of improved capabilities to detect underground tests within the Soviet Union. While the negotiations in Geneva had struggled along since the U.S. backed away from a preliminary finding in 1958 that verification of a comprehensive test ban was possible, including underground testing, as it turned out, AFOAT-1/AFTAC apparently rather quickly discovered the doubts the Air Force and other test ban opponents fostered about U.S. capabilities to detect underground nuclear tests were themselves erroneous. The Air Force overestimated the number of small quakes within the Soviet Union that could generate suspicious signals the Americans wanted the right to inspect. Likewise, the models used were based on data from testing in Nevada, where the test site's geology tended to muffle seismic signals, while testing in Russia at the Semipalatinsk site generated especially strong signals; the geological differences prevented the sort of exact comparisons that policy makers found comfort in, as well as helped feed the controversies associated with such red herrings as the Teller/Latter decoupling theory.[1138] One example was

[1137] Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," [Note: typed date of 29 July was corrected by pen to 23 July], Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 4.

[1138] Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," [Note: typed date of 29 July was corrected by pen to 23 July], Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 19-20. Foster asserted that the way in which tests conducted in the alluvium deposits in Nevada were transmitted amounted to "decoupling." This was a technically questionable assertion, since alluvium deposits are better said to attenuate the signal. Decoupling attempts to limit the initial transmission of a signal into the surrounding geology.

Senator Henry Jackson's (D – WA) belief in the permanent, mysterious nature of the Soviet threat.

> The real problem is the Soviet's unwillingness to give up what they continually brag about, secrecy.[1139]

Also known as the "Senator from Boeing," Jackson built his political career much the same way General LeMay built SAC, the customer for thousands of Boeing's aircraft, on a foundation that depended on construction of the ominous, unfathomable nature of an inscrutable Communist threat.[1140] Unlike LeMay, Jackson did not have access to the inside story of what the government really knew about the Soviet Union, which helped sustain his unremitting support for virtually every weapons system that crossed his desk.

Also disclaiming the effect of world opinion on the test ban negotiations, Foster noted a partial ban on atmospheric testing was enforceable without the need for inspections or monitoring locations in the Soviet Union. Nonetheless, Foster observed the positive political effects of such a ban as an alternative to a comprehensive test ban, since it "would have the advantage of stopping those tests which have caused greatest concern around the world, namely, tests producing radioactive debris."[1141] Despite several rejections of a partial test ban by the USSR, Foster observed a partial test ban was still in play behind the scenes in the negotiations.

Foster stated "substantial improvements in the ability to detect at long distances" were now available, yet members of the committee remained skeptical amid a chorus of political fears about the assumed inadequacy of the U.S. nuclear intelligence system. Despite most present being veteran members of JCAE, the naivety in evidence demonstrated the committee was largely unfamiliar with past and present nuclear intelligence efforts. Doyle Northrup responded to a question about the recent improvements in the capability of the AEDS, only to have Chairman Chet Holifield ask "What is this ADS[sic]?" Northrup rather cryptically advised the JCAE chair the AEDS was "the U.S. unilateral detection system." While Holifield was generally aware of what AFTAC was engaged in, his grasp of details was surprisingly weak, as he was referring to the AEDS or Atomic Energy Detection System, the Air Force's acronym for the

---

1139 Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," [Note: typed date of 29 July was corrected by pen to 23 July], Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 27.

1140 Jackson served on the JCAE as the chair of Subcommittee on Military Applications.

1141 Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," [Note: typed date of 29 July was corrected by pen to 23 July], Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 12.

combined networks of infrasonic, seismic, fallout sampling and other "unilateral" technical systems used to detect non-U.S. nuclear detonations and fissile material production, which AFTAC operated at the direction of the Joint Chiefs of Staff. Northrup then moved on to note the AEDS could in many cases now distinguish between seismic signals created by deep earthquakes and the signal of a nuclear test at more shallow depths, a capability to discriminate between natural and human-initiated signals he noted was not available in 1958. What worried Holifield, Representative Craig Hosmer (R-CA), and others was the proposed system was viewed as unable to pick up most of the recent low-yield underground shots in Nevada, raising questions about its detection capabilities.

In his questioning of Northrup, committee chair Holifield asserted "80 percent of the Nevada tests generated seismic signals so small as to make individual detection unlikely." AFTAC Technical Director Northup advised the JCAE the findings were not entirely new, but represented an evolving understanding of seismic wave behavior by AFTAC. Representative Hosmer was offended more certainty could not yet be attached to estimated capabilities of the monitoring system then under proposal.[1142] The committee's demonstrated general ignorance regarding AFTAC and its operations and capabilities was reinforced by badgering questions, such as Representative Hosmer's challenge to Foster, posed as, "Would you want to commit the security of the United States upon an empirical theory that has not been tested and has been evolved [sic] by one event?"[1143] Those charged with nominal oversight of the military and national security policy involving nuclear weapons remained remarkably uninformed about the role of fallout and nuclear intelligence despite several rounds of hearings on the matter.

Ultimately, Hosmer practically begged for a "range in terms of percentage possibilities of detecting and confirming." Foster replied, "I am not sure you can put a mathematical number on political factors. It is a matter of judgment." Hosmer charged "you are looking at the bright side of all this detection and inspection business and not equally evaluating the possibilities that might not be as happy for us." [1144] The exchange pointed out how persistent the clinging tentacles

[1142] Hosmer drafted and delivered remarks condemning the Geneva effort as "a peacemaker popularity package" that would lock the United States into a "deadly danger." Craig Hosmer, "The Test Ban: Safe & Unsafe Positions – Seismology – Scylla's Sirens," attachment in "Transcript of Executive Session, 23 July 1962," Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282.
[1143] Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 62
[1144] Ibid, 72, 83.

of nuclear absolutism remained. Even if it went undetected, no single nuclear test or weapon that might be missed by an otherwise extraordinarily effective technical surveillance system could fundamentally alter the balance of power between the U.S. and the USSR at the point where each already possessed thousands of these weapons.[1145] Hosmer found nothing publicly available to give confidence to his constituents, while seeing political gains could be made by raising questions about what was largely unknown even to representatives in Congress. Certainly, the first test by a new member of the nuclear club, as was readily detected by AFOAT-1 within Russia in 1949, was a matter of concern, but one in which the AEDS demonstrated an impressive track record of detection despite congressional ignorance about its accomplishments. By 1962, the bellicose oratory and political fears of the JCAE that defined the committee's very limited grasp of the capabilities of AFTAC also defined a virtual political requirement for the AEDS to detect each and every nuclear test, a quaintly obsolete standard amid the landscape of nuclear plenty that served far better as a poison pill to obstruct arms control initiatives than as a real-world assessment of what was necessary to ensure national security.

1962: Ten Years and a Cloud of Dust

Given the Cold War confrontation, it was surprising the Limited Test Ban Treaty was ratified just fourteen years after the Soviet Union acquired nuclear capability; it was also remarkable the United States came to terms with the hubris Robert Oppenheimer encountered when interacting with the United States military over the leap to thermonuclear weapons in just less than a decade after the IVY MIKE test. The conflict in evidence at the 1962 hearing between representatives of executive branch agencies and members of Congress who remained fearful of what they supposed were the many unfathomable secrets of the Soviet Union's nuclear program was emblematic of pervasive ignorance still surrounding virtually every aspect of AFTAC's operations and capabilities in 1962.

With testing underway in Nevada and near Christmas and Johnson Islands in the Pacific, along with preliminary negotiations with the Soviets on a test ban, on the cusp of the Cuban missile crisis Carl Kaysen prepared a 20 July 1962 memorandum for the president that discussed "New Data on Detecting Underground Nuclear Explosions." Kaysen explained AFTAC knew

[1145] Joint Committee on Atomic Energy, U.S. Congress, "Transcript of Executive Session, 23 July 1962," Kennedy Library, National Security Files, Departments and Agencies, Joint Committee on Atomic Energy Testing Hearings, Box 282, 68. Dr. Franklin A. Long of ACDA advised the JCAE that uncertainties in detection tended to work in favor of the detector over the course of a test series.

since 1958 the discrepancy existed in the measurement and recording of seismic signals, significantly attenuating signals from testing at NTS. Mistakenly assuming essentially the same geologic conditions prevailed at Semipalatinsk, AFOAT-1 analysts believed Soviet tests it recorded were of devices with considerably higher yields than in fact were tested. With less attenuation, these devices simply appeared to have higher yields. Nevada's geology contributed to a significant misunderstanding in applying this data to earlier yield measurements, but Kaysen related its exact nature only became clear during research conducted in the summer of 1961 as part of the VELA UNIFORM program on seismic detection improvement and only confirmed in the spate of testing beginning that fall.[1146] Kaysen's memo did not clarify the fact that seismic detection of many atmospheric tests, those on the surface, on towers, and detonated at similar, somewhat higher air burst heights, occurred even if not buried deep beneath the surface.

Another politically charged change anticipated at Geneva was the American decision to revise their estimate of the number of earthquakes whose characteristics could be mistaken for a nuclear test within the Soviet Union significantly downward in light of data generated by the upgraded seismic system put in place during the last years of the Eisenhower administration. This number was significant because it helped drive U.S. demands for the number of on-site inspections to resolve the origin of events demonstrating characteristics of nuclear explosions. The resolution was especially politically sensitive domestically because it happened to depend on a revised interpretation that arrived at a number that some were taken aback to find correlated with the original 1958 Soviet position.[1147]

Kaysen assessed a large part of the problem with evaluating detection capabilities was the intensely compartmented nature of AFTAC's operations.

> I think there is a significant moral to [be] drawn from the story. It is the fact that the highly accurate data which AFTAC collected on its new system was highly classified and its existence in detail was unknown to all except a few scientists inside the government…If the AFTAC figures had been made more widely available, or if AFTAC's activities had been reviewed in detail more frequently by outside scientists, the change in understanding and evaluation might have come a good deal more quickly. It is fair to say, of course, that this is speculation. How hard and how long a man has to look at new figures before he sees that they

[1146] Carl Kaysen, "Memorandum for the President: New Data on Detecting Underground Nuclear Explosions," 20 July 1962, John F. Kennedy Library, National Security Files, Box 300.
[1147] Carl Kaysen, "Memorandum for the President: New Data on Detecting Underground Nuclear Explosions," Kennedy Library, National Security Files, Box 300.

are inconsistent with an old theory remains one of the inscrutable mysteries of science.[1148]

In essence, the revision in assumptions underlying seismic detection appeared to present the possibility of political embarrassment, while offering a difficult narrative to explain to legislators and the public, let alone fully understand. But there were significant indications Kaysen was far too generous in his evaluation of what the Air Force was up to in sitting on such a significant revision in assumptions about the capabilities of a system to support a comprehensive test ban.

Gaming Seismic Capabilities to Shape Diplomatic Options

Oral history interviews with a number of scientists working on the seismic detection problem indicated less charitable reasons why it took years before anyone but the Air Force was aware of the significant new findings about these capabilities. Jack P. Ruina was a professor of electrical engineering at the University of Illinois and director of a group doing radar work there. Taking leave from the University, he was appointed Deputy Assistant Secretary of the Air Force for Research and Development. Herbert York asked him to become director of the Advanced Research Projects Agency, where he served from 1961 to 1963 at a time when the VELA UNIFORM underground detection R&D program was a high priority. Ruina's primary contact with the White House was through Carl Kaysen, who received a briefing from Ruina and others on the detection issue as did Secretary of Defense Robert McNamara. Ruina's impression of AFTAC's Carl Romney was his work was "most expert" but "nobody could argue with him" because he alone held access to AFTAC. The meeting where Romney sprang news of the revision in Russian earthquake estimates at the State Department came "as a total surprise." While AFTAC's handling of the data seemed forthright to Ruina when he explained it to McNamara in a memorandum analyzing the history of the problem, his conclusion was one that went the root of the matter. When one person, or organization in this case, interprets the data without peer review "mistakes can occur." With the proper clearances, Ruina never felt AFTAC withheld data, but "they would never volunteer."[1149] It was one thing to ask, holding the proper clearances as Ruina did, for sensitive data and get it. Conflicts over seismology presented none

[1148] Carl Kaysen, "Memorandum for the President: New Data on Detecting Underground Nuclear Explosions," Kennedy Library, National Security Files, Box 300.
[1149] Interview of Jack P. Ruina by Kai-Henrik Barth on 29 May 1998, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/5903<http://www.aip.org/history-programs/niels-bohr-library/oral-histories/5903>. Ruina, along with Charles B. Archambeau, pointed out the tranche of funding for VELA UNIFORM was instrumental in the vast advances in seismology made during the late 1950s and early 1960s.

of the existential issues for the Air Force that fallout did. Thereby hangs the thread of why the military made the initial proposal for a test ban with an underground exception to Eisenhower in 1958. Carl Romney's timing in announcing a breakthrough satisfying the Air Force's concerns in adequately monitoring the Soviet nuclear program under a test ban sharply limiting fallout by pushing testing underground may have been coincidental, but the selective and restrictive release of such data clearly reflected internal processes ensuring such decisions on policy were neither accidental or unplanned.

Others with even closer experience with AFTAC during this period suggest an even less charitable interpretation. Charles B. Archambeau was another seismologist who owed his education to VELA UNIFORM, leading to a contract job setting up and operating the data center AFTAC used to monitor incoming seismological data from the AEDS. His view was that Romney had a "cynical view of the detection problem…did not believe it had a solution…and didn't care whether the problem got solved or not." In at least one case, Archambeau believed he had a workable solution for a problem, but was actively discouraged from pursuing it. While Archambeau did not feel there was a "conspiracy" to obstruct science, he agreed there was at least some truth to a colleague's assessment that VELA UNIFORM "was just a charade."[1150]

The curious timing of Romney's seismic revelation makes more sense once placed in the context of the Pentagon's 1958 conditional initiative to end atmospheric testing. These events could be read simplistically as the results of the Air Force gaming things to its benefit. But consider Jack Ruina's evaluation of Romney and AFTAC – "they would never volunteer" information unless specifically asked. Both instances reflect remarkable exceptions to that rough rule of bureaucratic thumb, as if the military was asking to be relieved of a burden, on the one hand, and sharply defining what it found acceptable policy in its place with the other one. And if one takes the same general approach of Romney, where secrecy ensured he had expertise in his corner, and applied it to the rest of AFTAC mission, the unit was, of course, well aware of the significantly increased fallout from the moment its sensors first detected the wave form of radio signals on the EMP detectors of the AEDS from each nuclear event.

Evidence of the Air Force volunteering a solution to the fallout problem in 1958 strongly suggested that as American fallout production nudged up to and over the original 60 megaton

[1150] Charles B. Archambeau, oral history interview and notes by Kai Henrik-Barth, 18 June 1998, Center for the History Of Physics, American Institute of Physics. http://www.aip.org/history/ohilist/5899.html.

limit first suggested by GABRIEL, those who initially wanted to suppress that study now looked to it as a rough yardstick suggesting caution – and they had the lab reports in hand to reinforce those concerns.[1151] Romney's role in the summer of 1962 was as a closer – he was there to declare they had the best deal possible on the table and that it was acceptable to the Air Force provided the underground exception was maintained on principle. Seismic methods were vastly improved and regional geologies better understood, so it could better serve than previously for intelligence purposes. However, political realities meant the difficulty of discriminating seismic signals from noise at the limits of detection ruled out a comprehensive arms control treaty, an absolutist standard that was far more effective serving as political boilerplate for nervous politicians than an assessment of the overall capabilities of the seismic technique, given the record of remarkable success established by the AEDS of using multiple techniques to detect each test.

As with the 1949 public announcement of Joe-1, secrecy inside the government proved amendable, especially when it served the institutional interests of the Air Force. This institutional interest now included putting a stop to fallout in order to limit future access to fallout data by researchers, as the Air Force recognized its growing ubiquity in the environment meant loss of its near exclusive access to this previously held virtual monopoly even as fallout continued to rain down was now being transformed into an increasingly troublesome body of evidence. After little more than a decade, the 1961-1962 Russian fallout campaign also sundered the cumulative limits the AEC apparently closely observed in its test series following the 1954 CASTLE BRAVO incident, limits on fallout the United States hoped would limit the controversy it produced when generated by testing. Presumably, the reasons to end fallout were as objective and empirically based as those applied to conflicts over seismology, yet fallout remains a surprisingly sensitive subject, with the substance of the key data that shaped this policy change still largely off-limits for reasons of national security.[1152] The Air Force's voluntary proactive action setting the bounds for post-atmospheric nuclear testing strongly suggested its empirical findings on fallout turned out to be alarming and constraining enough to cause it to convert to caution in 1958 and follow up that with support for ending fallout four years later in 1962. There certainly was no effort to

[1151] As noted previously, American testing through CASTLE produced about 60 megatons of total yield, with a high percentage of that being fission yield.
[1152] Seismologists produce a significant historical database of earth movements made available in the normal course of their work.

explain this significant, even jarring change, why it abruptly shifted from treating fallout as inconsequential to promoting its end as a policy. However, it did buy time and opportunity for another couple of rounds of testing devoted to arming another generation of bombs, newly arming missiles and exploring electromagnetic pulse effects. In effect, the Air Force appeared to have chosen a delaying action in order to avoid the stringency of an abrupt halt to fallout by choosing when to "volunteer" new information about seismic detection capabilities in conjunction after having aligned the moon and the stars to bring stratospheric fallout back to earth to test the theories of Libby and the Weather Bureau on the pace of fallout's return from the upper atmosphere.

Enough Numbers to Know

With statements like those of General Power accompanying General LeMay's somewhat more tight-lipped leadership, the Air Force remained outwardly untroubled by the potential for cumulative fallout that apparently alarmed Oppenheimer and others in the scientific community through the bulk of the nineteen-fifties. First expressed in the initial findings of the GABRIEL study, which found the allowable scope of an American attack on the Soviet Union was limited to 60 megatons of fission yield before it created significant health impacts on Americans, GABRIEL's limits were later revised upwards to 2,000 megatons in an apparent accommodation that correlated with the Air Force's waxing aspirations for thermonuclear weapons after Joe-1. Following Oppenheimer's mid-1952 departure as the GAC chair and after the 1953 RAND conference, GABRIEL was buried deeply in Libby's Project Sunshine. By the time that Kennedy took office, the United States stockpile could support an attack with a total yield of roughly ten times the later yield (2,000 megatons) or 333 times the original yield (60 megatons).[1153] While total stockpile yield includes both fusion and fission, unlike GABRIEL's pre-thermonuclear estimate of fission yield, the approximately 20,000 megatons in the stockpile circa 1960 represented roughly an order of magnitude larger potential fallout threat than that provided by the circa 1950 revised GABRIEL 2,000 megaton fission yield total. The calculations may be more fuzzy than exact, but in the absence of the classified data and conclusions that could best

[1153] Stockpile equivalent yields are expressed as fission + fusion totals in Appendix D; fission yields would be less, depending on the design of each device, its relative percentage of the stockpile population, and the delivery tactics employed in wartime use. Rather than exacting numbers, the point is to demonstrate the similarities and obvious exceptions of scale, scope, and order of magnitude that point toward the original calculated limit of 60 megatons held up rather better than the refinements apparently made to accommodate thermonuclear weapons. Roughly half of the U.S. total yield is attributable to fission, although individual devices varied widely from very dirty to 90%+ "clean."

describe the issues at stake, they will do. Regardless of the exact outcome of combat between two or more nuclear-armed parties, the resulting fallout would clearly be on a scale that would devastate human health and the environment.[1154]

Between information revealed at the 1957 and 1959 fallout hearings and the incidents involving wheat and milk contamination, another rough but extraordinarily revealing comparison becomes possible that illuminates the circumstances behind the decision to cease atmospheric testing due to the threat of fallout. Ralph E. Lapp summarized most of the relevant statistics and data in a report after the 1959 hearing, "Fallout Hearings: Second Round," in the September 1959 *Bulletin of the Atomic Scientists*. Lapp observed that the 1957 fallout hearing saw the AEC reveal an annual quota for adding fallout to the atmosphere, 10 megatons of fission yield. The AEC argued that if no more than this amount of fallout was added, decay of previous fallout would result in no net increase in annual exposures due to global fallout from testing. Two years later during the second round of fallout hearings, it was revealed as of the May 1959 date of the hearing that total yield from testing by all nations (US, UK, and USSR) was 173.4 megatons, including 91.7 megatons of fission yield (or ~53% fission yield). One important disclosure that Lapp noted received no publicity at all was confirmation that CASTLE BRAVO and likely many other thermonuclear weapons derived a large part of their yield from fissioning of their uranium tamper and case, as well as other components, part of the technology that implemented the multi-stage design of the Teller-Ulam concept. Since CASTLE BRAVO, the AEC encouraged the president and public to believe that fusion could theoretically provide "clean" weapons, but this admission demonstrated for all practical purposes there was still plenty of fallout produced by thermonuclear weapons. Lapp then noted the varying interpretations of the rate at which fallout deposition of strontium-90 was reflected in its uptake by humans, highlighting a disagreement between Libby and J. Lawrence Kulp, another Sunshine researcher, over the permissible levels of strontium-90 in food and human beings.[1155] What was most notable was that the dispute indicated the argument about the threat posed by wartime fallout now resolved toward the low end of GABRIEL's estimates. Libby's argument with Kulp was over how deposition rates

[1154] The numbers of operational weapons systems held by each of the five major nuclear-weapons holding states are likely sufficient so that each could, on its own, expend more than the requisite 60 megatons of fission yield that the original GABRIEL study suggested was problematic at the global level. While this is unlikely to be a strategic goal of their plans, it would be a likely result of a significant nuclear conflict.
[1155] Ralph E. Lapp, "Fallout Hearings: Second Round," *Bulletin of the Atomic Scientists*, Vol. XV, No. 7 (September 1959), 302-307.

affected the relative odds of exceeding the recommended maximum body burden level of strontium-90, rather a case of trying to move the goal posts in the middle of the game. The fact that an argument intended to apply to wartime fallout was under discussion in regard to fallout from protracted testing in itself gave away the game that such effects took place at the lower end of the scale GABRIEL calculated. As a quick, back-of-the napkin calculation here is why.

With the end of testing due to the temporary test moratorium, Libby estimated that as of early 1959 about 42 megatons of fission yield remained aloft, primarily in the stratosphere.[1156] This correlated with findings of the AEC Fallout Prediction Panel, also presented at the 1959 hearings, which found that of the approximately 90 megatons total of fission products injected into the atmosphere, one third was deposited as local fallout in relatively close proximity to the point of detonation, one third was carried aloft and already fallen back to earth as global fallout, and one third, or 30 megatons, remained aloft. The panel estimated the United States and British fission products total for testing during 1957 and 1958 as equivalent to 19 megatons, based on a total yield of 42.3 megatons. Soviet total fallout for the same period was 22.5 megatons, suggesting a Russian fission fallout total of roughly 12 megatons[1157] Add the two estimates of fission products aloft from recent testing in both East and West provided essentially the same estimate of the equivalent fission products still aloft as that of Libby, 42 megatons.[1158] Then for a little over two years, there was no new fallout.

Greene made it clear that in secret Eisenhower concluded by March 1959 that "…nuclear testing is bad," a decision reinforced by the scare over rising strontium-90 levels in Minnesota wheat before the 1959 hearings.[1159] Set aside the specific arguments, and there were no conclusive ones, over what level of which isotope was tolerable in wheat, bread, or humans. Fallout might not immediately sicken anyone, but it was politically intolerable for wheat to expose humans to it in excess of a level the government itself set. Although they did not call attention to this fact, Libby and the Fallout Prediction Panel both essentially agreed even as they argued that the AEC data showed the atmosphere held substantially *less* than 60 megatons of fallout generated over a period of years, rather than that which would be released within a few

[1156] Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2536-2537.
[1157] Ralph E. Lapp, "Fallout Hearings: Second Round," 304. The panel suggested Soviet testing was relatively more "dirty," but this estimate assumes marginally dirtier.
[1158] Some of the 42 megatons of yield total was undoubtedly contributed by testing prior to 1957. This example calculation is important in terms of orders of magnitude.
[1159] Greene, *Eisenhower, Science Advice*, 184.

hours by a nuclear attack likely to take global cumulative fallout to far past that original GABRIEL-predicted level. Given Eisenhower's lengthy history with fallout, whether or not he was specifically cognizant of the GABRIEL findings was less relevant than the significance of those around him who likely were aware of it, like Libby, Teller, Twining, and LeMay, turning more cautious about fallout. Given the controversy, lengthy lead time, and the classification barriers to be overcome for such research, the data analyzed by the Fallout Prediction Panel was already being assembled in 1958 when Walter Singlevich began showing up to represent the Air Force's interests in the dispute between the Weather Bureau and Libby over fallout residence time.

Forward the narrative to Carl Kaysen's advising John F. Kennedy on arms control and the picture was even grimmer by the time he wrote the July 1962 memo on the potential to seismically verify a comprehensive test ban. The Soviet Union generated 83 megatons in total yield in 1961. Before Kaysen's July memo, there was only one Soviet test in 1962, the somewhat hopeful second Soviet underground test on 2 February 1962, a tiny device with a yield estimated as between 10 tons and 20 kilotons. About half of the total 1962 United States atmospheric yield of 36 megatons was already mixing with the Soviet fallout. Spring brought with it the deluge of iodine-131 and other isotopes Lester Machta came to expect and that Jerry Wiesner was forced to deal with beginning in June 1962 as it pushed up radiation levels in milk that alarmed mothers across the United States and around the globe. With a metaphorical napkin at hand, let us jot down what is known from the evidence in this narrative.

42 megatons	Libby estimated fission yield fallout aloft, 1959[1160]
Minus 28.3 megatons	Estimated fallout deposited (-10 megatons annual rate for 34 months)[1161]
13.7 megatons	Estimated fallout aloft when testing resumed, 1 September 1961
28 megatons	Estimated Soviet fission fallout products added, 1961[1162]

[1160] U.S. Congress Special Subcommittee on Radiation, Joint Committee on Atomic Energy. *Fallout from Nuclear Weapons Tests, 5-8 May 1959*. Washington, DC: USGPO, 1959; U.S. Congress Special Subcommittee on Radiation, Joint Committee on Atomic Energy. *Fallout from Nuclear Weapons Tests, Volume 3*. Washington, DC: USGPO, 1959.

[1161] U.S. Congress Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, *The Nature of Radioactive Fallout and Its Effects on Man*, 27-29 May and 3-7 June 1957, Washington, DC: USGPO, 1957. From 1957 fallout hearings, limit of 10 megatons/year additions said to keep deposition levels no higher than then-current deposition rates. No fallout was added from early November 1958 through August 1961. With an assumed deposition rate of 10 megatons/year x 2 years and 10 months = 28.3 megatons deposited.

[1162] One third of the 1961 USSR 83.23 megatons total yield, based on 1957 assessment of CASTLE BRAVO fallout. The United States did not test in the atmosphere in 1961 and did not do so until April 1962, before the significant iodine-131 contamination in milk came to notice.

42 megatons	Estimated fission fallout aloft, 1 January 1962

Within a few months of the resumption of atmospheric testing, in late 1961 by the Russians and then in 1962 by the United States, the calculated global atmospheric fission fallout burden rose quickly back to early 1959 levels.[1163] It was also fresher, which helped account for the problems with iodine-131, a relatively short-lived isotope produced in such quantity that it spread like never before. Fallout's threat was direct and already present even in peacetime in the eyes of mothers caring for vulnerable children.

Note carefully which GABRIEL estimate of unacceptable fallout was closer to the magnitude of observed results of actual fallout, 60 megatons or 2,000 megatons?

Certainly, the actions taken by the executive branch were significantly influenced by public opinion and political pressures. Kennedy's decision mirrored Eisenhower's in reacting swiftly to stem the political bombshell of citizen-consumer response to an attack on the world's children. In acting to address problematic milksheds, Kennedy's decision to cease atmospheric testing was also clearly tied to standards the government set, not simply the product of the vague moral considerations cited by both sides at the Oppenheimer hearing as a partial explanation motivating his actions. However uncertain or scientifically controversial they may have been, these standards provided empirical yardsticks that played major roles in both Eisenhower's and Kennedy's decisions to end fallout.[1164] The controversy between Libby, Kulp and others in the scientific community over strontium-90 body burden limits was just one example among many. There was substantial certainty, though, directly demonstrated under two presidents who dealt with the national security and public health consequences of fallout that the order of magnitude of its ill-effects on human health and the environment became a policy problem far closer to GABRIEL's 60 megaton original limit than it was to the sharply revised upward 2,000 megaton limit GABRIEL later suggested. Some in the Air Force could argue in secret for a redoubled effort to sell the public on tolerance for higher fallout exposures, but it was an idea that was politically, if not radiologically, sterile long before Kennedy took office.

[1163] Note that numbers have been rounded and approximated. Given this argument requires only an order of magnitude determination, the precision is adequate.

[1164] John H. Finney, "Fallout Hazards to Health 'Small,' U.S. Study Asserts," *New York Times*, 2 June 1962. Eisenhower established the Federal Radiation Council in 1959, in part because of the perception that the AEC had a conflict of interest in setting exposure standards while at the same time exposing the population to fallout from testing. The FRC delivered a report to Kennedy that portrayed the health impacts of fallout as minimal in early June 1962. Kennedy used its preliminary conclusions earlier that spring to base his decision to resume atmospheric testing in 1962 after the Russians broke the moratorium and did so themselves in September 1961.

LITTLE FELLER, Big SEDAN, and Big Fallout

In an otherwise crisis-filled year, atmospheric testing ended with several dozen bangs in the remote Pacific, but just a relative whimper of four very low yield shots in Nevada.[1165] The largest was but 1.65 kilotons, while two tests of the Davy Crockett battlefield nuclear rocket generated just 18 and 22 *ton* yields, respectively. A Department of the Army film emphasized the weapon's prompt radiation effects as a killing and incapacitating feature, but downplayed the lingering threat of fallout by focusing coverage about it on a recitation of protection measures taken against it.[1166] Describing LITTLE FELLER I, the narrator breathlessly noted the precision of the maneuver and then pointedly observed an explicit inclusion of an extraconventional effect.

> It detonated perfectly, releasing its lethal radiation…[which is among] the three basic effects of nuclear weapons, heat, blast, and nuclear radiation.[1167]

The bigger fallout issue at NTS in 1962 was an ostensibly underground, but only partially contained cratering shot in Edward Teller's Plowshare program to utilize nuclear devices for peaceful civil engineering and other purposes. Just prior to the DOMINIC II shots, shot SEDAN (104 kilotons, 6 July 1962) released 880,000 curies of iodine-131, placing it just behind HARRY (32 kilotons, 19 May 1953) in producing the most intense fallout over the continental United States from testing in Nevada.[1168] The dirty nature of the shot was first discovered by the public when a University of Utah radiology professor leading a field trip for graduate students noted "all the measurements began to go nuts."[1169] While touted as sharply limiting fallout, the fact that

---

1165 Even underground tests could be dirty. Some simply leaked. SEDAN, a "peaceful nuclear explosions" (PNE), spewed masses of poorly-tracked fallout just weeks before the handful of test shots associated with DAVY CROCKETT.

1166 Defense Nuclear Agency, Operation DOMINIC II: Shots LITTLE FELLER II, JOHNIE BOY, SMALL BOY, LITTLE FELLER I, 7 July - 17 July 1962, 58-60. Instead of select personnel received dosimetry film badges and dosimeters as at previous test, all military field personnel were issued film badges and pocket dosimeters for this test series. Ground teams covered an area as far as 320 kilometers away, while the Air Force's 55th Weather Reconnaissance Squadron provided long range cloud tracking, as well as cover for AFTAC's involvement. While reported as making great strides in radiological safety, fallout monitoring and mitigation was still a haphazard game. One procedure to deal with the problem of engine contamination reportedly involved shooting fire hoses into the intakes of the running jet engines of the WB-57 samplers.

1167 Department of the Army, *IVY FLATS Film Report* (MF 20-9811), 1962.

1168 SEDAN was the second dirtiest known shot based on declassified records. Given a significant bulk of data remains closed to researchers it is possible that another shot deserves this dubious honor.

1169 Harvey Wassermann and Norman Solomon, *Killing Our Own* http://www.nucleardemolition.com/Killing_Our_Own.pdf , cited in Comprehensive Test Ban Treaty Organization, "6 July 1962: 'Sedan' - Massive Crater, Massive Contamination," http://www.ctbto.org/specials/testing-times/6-july-1962-sedan-massive-crater-massive-contamination/. SEDAN's fallout impacted preparations for sensitive equipment associated with LITTLE FELLER elsewhere at NTS. See: Defense Nuclear Agency, Operation DOMINIC II: Shots LITTLE FELLER II, JOHNIE BOY, SMALL BOY, LITTLE FELLER I, 7 July - 17 July 1962.

both of the DAVY CROCKETT test devices were detonated three feet above ground level, as well as once more as a special atomic demolition mine in a shallow, two foot deep burial site mimicking a hasty, improvised emplacement, suggested adoption of tactical weapons failed to make much of a difference in the threat posed by fallout under battlefield conditions. The results from SEDAN suggested so-called peaceful nuclear explosions shared much the same hazard as military weapons did, unless fully contained underground. Even underground testing, while by intent better contained than SEDAN was, frequently leaked detectable levels of fallout due to containment failure during underground test shots.[1170] It was rather remarkable SEDAN did not draw the same interest in radiological safety and monitoring that LITTLE FELLER did.[1171] At the end of atmospheric testing in 1962, NTS supported only the lowest yield testing and remained the site of miscalculation about the potential for tests to go awry due to escaping fallout.

<u>1962</u>: Almost War: Fallout and the 4080th's Cuban Missile Crisis

As another significant part of the narrative whose essential role we have only touched upon briefly, pointing to the value of the unit's declassified history as well as to the contributions of its exploits, the 4080th Strategic Reconnaissance Wing and its U-2 aircraft were remarkably busy during that fateful October when the Cuban Missile Crisis brought the superpowers to the brink of nuclear war over Soviet missiles stationed in Cuba. Twenty-three of the wing's U-2 aircraft were assigned to seven operating locations that ranged from Alaska to Australia. To the already far-flung missions of the 4080th SRW were added monitoring and sampling test shots in

---

Subsequent recalculation of SEDAN fallout indicated it was far and away the dirtiest of continental U.S. tests in terms of effective dose. However, there remains dispute about the accuracy of this finding. See: http://www.cdc.gov/nceh/radiation/fallout/feasibilitystudy/Technical_Vol_1_Chapter_3.pdf , 50.

[1170] U.S. Congress, Office of Technology Assessment, *The Containment of Underground Nuclear Explosions*, OTA-ISC-414 (Washington, DC: U.S. Government Printing Office, October 1989). Full text: http://www.archive.org/stream/containmentofund00unitrich/containmentofund00unitrich_djvu.txt. Chapter 3: https://www.princeton.edu/~ota/disk1/1989/8909/890905.PDF. The Department of Energy argued that only 4 of more than 200 shots from 1970 to 1989 stuffed containment failure following efforts to ensure successful containment following the BANEBERRY test in 1970. Other estimates of containment failure in underground testing range from 10% to 15% up to 50%, See Peter Grogden, "Underground Nuclear Testing: The Old Arrogance Remains," Science For Peace Bulletin, November 1991, http://www.scienceforpeace.ca/underground-nuclear-testing-the-old-arrogance-remains. While the volumes were low in comparison to atmospheric testing, they were nonetheless detectable across international borders, thus constituted technical violations of the 1963 LTBT..

[1171] The attention paid to radiological safety at LITTLE FELLER I and II was a Potemkin village of sorts, with dignitaries and visitors asked to focus great attention on the matter onsite in the Army film of the test operation. Off site, Richard Miller reported that the AEC did not bother to track LF I beyond the NTS border, while it followed the earlier shot, LF II, only to "southwestern Colorado." Miller 341-342. Given Miller was unaware of the bulk of AFTAC's activities and capabilities, his lack of knowledge about them likely led him to assume no further tracking took place, when that was unlikely to be the case; AFTAC's role was simply still classified.

the DOMINIC series in the Pacific, operating samplers directed at Soviet nuclear test plumes, and training for its emergency war order (EWO) role, was an additional operating location, OL X. The unusual domestic OL was established at McCoy Air Force Base, Florida with five U-2s deployed from the 4080th home base of Laughlin AFB, Texas on a mission code-named BRASS RAIL. While photographic and electronic reconnaissance missions were practiced, operational deployments were primarily nuclear intelligence operations dedicated to capturing samples at various altitudes and locations. The exception was newly-minted OL X, where in the more conventional role of aerial photography a 4080th SRW U-2 flying from Laughlin AFB in Texas landed after crossing the island on Mission 3101 on 14 October 1962.[1172] The imagery that Mission 3101 returned for analysis offered proof of suspicions gathering for weeks before the fateful October 1962 day, when it precipitated the crisis in the form of images of a Soviet intermediate-range ballistic missile battery under construction. The wing later lost one of its own, Major Rudolf Anderson Jr., when his aircraft was brought down by a SAM (surface-to-air missile) on a mission over Cuba in the midst of the crisis on 27 October. The bulk of BRASS RAIL operations directed at Cuba during the crisis remain classified, however, contained in a Top Secret appendix to the unit history.[1173]

While the plane went into Air Force service in 1957, was a familiar sight around its home base in Texas and written about in its international travels to Argentina, Australia, and Japan, among other operating locations, the public knew it primarily as the “spy plane” flown by the CIA given most first heard if it following the Powers shootdown in 1960.[1174] Cuba was the debut of the U-2 in the public’s eyes as a familiar part of the Air Force’s military operations. With so little understood about fallout’s Cold War role, this mantle of spying inherited from the CIA was attractive enough to lead the public and most historians away from the aircraft’s original Air Force mission, as a valued asset used for nuclear intelligence and fallout sampling at previously

[1172] Pocock, *50 Years of the U-2*, 165-170. Pocock noted the dispute over whose pilots, the Air Force’s or the CIA’s, would fly these missions saw it go to the Air Force, because of the possibility of a shootdown. Interestingly, the mission was flown with one of the Agency’s higher performance U-2F models hastily repainted into a military registration.

[1173] Arthur C. Warfel, “4080th SRW October 1962 Unit History” - Reel 970, AFHRA, Maxwell AFB, Alabama. BRASS RAIL was the code name for the Cuban overflight mission largely conducted from OL X.

[1174] The author saw U-2 aircraft of the 4080th SRW perform several times at airshows in Texas in 1961-1963. The aircraft would roll from a taxi onto the runway, lift off in short order, and then the pilot would stand the plane on its tail as it climbed vertically out of sight, an impressive feat for what was basically a powered glider. The 4080th SRW unit histories show it tracked reports in the local press about the unit’s various deployments, with copies of various clippings often forming part of an appendix to monthly reports.

virtually unreachable altitudes. As with much else about fallout, once the LTBT was ratified, this niche fallout carved for itself just beyond sight of historians and the public's imagination faded out of Air Force history. However, a 4080th SRW U-2 did come within spitting distance of making an even more tragic sort of history – nearly precipitating nuclear war at the very moment the crisis over Cuba peaked because SAC, still led by General Power, prioritized fallout sampling over what in retrospect was basic common sense.[1175]

Flying from OL 5 at Eielson Air Force Base in Alaska, a 4080th SRW sampling mission on behalf of AFTAC resulted in a U-2 straying into Soviet airspace over Siberia late on the night of 26 October 1962, lasting into the day Major Anderson was killed by a SAM over Cuba.[1176] While this project's view of fallout as a material actor was intended in part to avoid the pointless anthropomorphism of assigning it human characteristics, the Air Force's stubborn pursuit of fallout came close to fostering its spawning by means of nuclear war, as if it were a parasite seeking to trick its host into aiding its reproduction. While the potential consequences remain a hypothetical, what was particularly alarming about the incident was that a slightly different outcome very well could have brought that to pass even without the creative fiction of intentional, self-serving fallout. Chris Pocock's description of the incident was accurate and clear.

Piloted by Major Charles Maultsby, the plane flew a mission first accomplished twice the month before, a grueling trip of at least eight hours to the North Pole and back, most of it navigated by celestial sightings given the disruptions to magnetism and radio waves produced by the polar region. It was a time of maximal effort in testing, so tense already. The USSR was the last in terminating this fevered pitch of testing, detonating forty-five tests in the last three months of 1962 before its final atmospheric shot on 25 December 1962. The risky polar flights ensured fallout from the USSR's Novaya Zemlya testing ground was captured. In a high-altitude pressure

---

[1175] This incident during the crisis was not the only questionable decision Power had a hand in. He apparently authorized radio transmission of the order raising the threat level to DEFCON II, just short of war, in the clear (without encryption of any kind) to SAC units and aircraft. DEFCON is the acronym for "defense readiness condition." See http://en.wikipedia.org/wiki/DEFCON. While it certainly delivered a sobering message to the Russians, Power made the decision without consulting with his commanders even as Kennedy and his advisers were working to establish a calm but firm dialogue with the USSR. See Raymond L. Garthoff, "Reflections on the Cuban Missile Crisis," The Brookings Institution, Washington, DC, 1987, 37–38.

[1176] 4080th SRW, 1962 Unit History, October 1962, 17. OL 5 sorties were "flown as directed by the Air Force Technical Applications Center (AFTAC) to intercept and monitor the debris resulting from the Soviet Union's nuclear weapons detonations at Novaya Zemlya…with the routes and take-offs being planned by the AFTAC representative at Eielson Air Force Base, Alaska."

suit in the cramped U-2 cockpit, the lone pilot could move just enough to work the controls and the sextant needed to "shoot the stars" for position reports. Maultsby ran into a common problem with this otherwise venerable, reliable method for navigation in northern latitudes – an intensely bright aurora borealis obscured his vision, blotting out his ability to focus on the specific stars he needed for navigation. Flying by dead reckoning, Maultsby crossed what he hoped was the North Pole, where any turn was south. Emerging from clouds that also plagued his flight, further sightings revealed he was far off track, but exactly where was uncertain until his radio began picking up Russian music as he neared the coast visible ahead! With fuel running low, Maultsby made a left turn in the general direction of Alaska. Pocock related McNamara ordered all sampling missions worldwide cancelled the next day, after Maultsby's wandering flight drew the attention of Nikita Khrushchev and the Soviet air defenses, though they proved unable to intercept him. John F. Kennedy bluntly assessed, "there's always some sonofabitch that doesn't get the word." Robert Kennedy recalled the Soviet leader's pained reaction in a diplomatic note to his brother in the midst of the ongoing crisis the day after.

> What is this, a provocation? One of your planes violates our frontier during this anxious time we are both experiencing, when everything has been put into combat readiness. Is it not a fact that an intruding American plane could easily be taken for a nuclear bomber, which might push us to a fateful step?[1177]

Pocock argued it was uncertain whether the president's earthy language referred to Maultsby or to the commanders who assigned the mission; Kennedy then let the matter drop, suggesting the whole affair was largely incidental or an oversight.

Given Maultsby's flight was directed by AFTAC on behalf of the Joint Chiefs of Staff, there was little doubt who produced the orders for the mission. The extant order reflected a confused chain of command fixated on fallout even in the midst of preparing for imminent war. In fact, the stand-down imposed on the Air Force U-2 sampling fleet on 27 October, which shifted its operational status to comply with the DEFCON II status SAC generally observed due to the crisis, was short-lived and unevenly applied.[1178] Putting emergency war order (EWO)

[1177] Pocock, *50 Years of the U-2*, 176-180; John F. Kennedy quotes cited by Pocock from Ex Com transcript and from Robert Kennedy, "Thirteen Days," 210.

[1178] The 4080th SRW was a SAC unit, one of several specialized reconnaissance units LeMay established. While they were SAC-controlled units for normal operations, like the 4080th they frequently operated under JCS or other national command authority orders. While SAC and much of the rest of the U.S. military went to DEFCON III status on 22 October, SAC units were ordered to DEFCON II for the first time in history the next day, 23 October, then remained at DEFCON II until 15 November.

operations into effect with the U-2 required downloading the various sampler modules used to acquire and collect fallout and other nuclear materials.[1179] This made room for equipment required to meet the EWO mission. While not specified in the official history, this probably included aerial photographic equipment for bomb damage assessment, the airborne "sferic" or EMP detection system, and likely included the limited electronic countermeasures available at the time. Exemplary of the confusion was OL 14 on Guam. Having made the switch-over to EWO alert status and prepared its aircraft for orders to launch, OL 14 was informed on 28 October that the "…sampling missions had a higher priority than DEFCON II." The EWO gear was off-loaded and the sampling gear re-installed. New orders then arrived from SAC "that all air sampling missions were cancelled until further notice." The uncertainty was recalled as finally resolving itself when orders arrived on 31 October to return to the assigned sampling mission routine.[1180]

Amid the confusion, Airman Warfel's official narrative and Pocock's adherence to it were called into question by a supporting document in the unit history appendix indicating their interpretation's underestimation of fallout's value to SAC. SAC message ZIPPO 10-695 on 28 October 1962 addressed to OL 14, corrected ZIPPO 10-686 from the same date. Whether initially issued in error or reconsidered after the fact, the message indicated the original stand down order for sampling applied only to OL 5, Eielson AFB, Alaska, and OL 7, Upper Heyford Air Force Base, United Kingdom.[1181] OL 7 handled sampling flights targeted from the west at plumes drifting out of Novaya Zemlya, essentially a bookend to the work of Alaska-based OL 5 over on the Siberian side of the polar circulation patterns, while maneuvering past nervous NATO partner Norway's territory. Shutting down sampling from OL5 and OL7 virtually eliminated the chance of coming into conflict under mistaken intentions; the other operating locations were distant enough from the Soviet Union for straying penetration flights to not be a factor, an order for all but the two affected operating locations to continue sampling operations. Given the circumstances, the high priority SAC continued to assign to nuclear intelligence operations was remarkable even as it prepared thousands of bombers and missiles for war.

[1179] The aircraft were often configured differently depending on the mission. In addition to the usual particle filter, a compressor and high pressure storage bottles often collected gases, although the compressor proved mechanically problematic early in the program.
[1180] 4080th SRW, 1962 Unit History, October 1962, 22.
[1181] 4080th SRW, 1962 Unit History, October 1962, Appendix, SAC message ZIPPO 10-695, 28 October 1962. The addressees specifically included "CSAF," General LeMay, in its distribution list, as well as AFTAC, intermediate headquarters, 4080th SRW headquarters in Texas, and the various operating locations.

SAC was poised to go to war at DEFCON II beginning on 22 October and did so a day later, yet it took until late in the day on 28 October before the clumsily handled matter of what the 4080th's U-2s should do resolved back to collecting fallout, while avoiding the possibility of sending mixed messages to the Soviet Union by cancelling missions from operating locations with the greatest potential for catastrophic misinterpretation. Certainly, getting badly disoriented during polar flight was a well-known problem and the challenges of doing so in the U-2 even more daunting; the potential for error played a significant role, given the Air Force's tendency to push the limits imposed by political authority, a force General Curtis LeMay led from 1961 until his retirement in early 1965. LeMay apparently conceded the danger, both of accidental nuclear war and that he was the misbegotten character the president was referring to in ensuring the problem was resolved; his own personal intolerance of incompetence likely ensured the "follow-up" down the ranks resulted in the confusing series of orders from SAC sending the 4080th's crews scrambling back and forth for the 48 hours or so following the fortunate recovery of Maultsby's errant mission. The order of business was then resolved with a stand-down of OL 5 and OL 7 and business as usual for the other sampling crews and support staff scattered around the globe. This may have reflected the persistence of General Power's frustration with the end of fallout coming into conflict with might have been seen as LeMay's accomodationist stance, where the Air Force quietly surrendered fallout to undercut the possibility of even more restrictive policy directives from civilian leadership that were the real threat to the Air Force's freedom of action.

What to Tell the White House

Indecision over readying the U-2 for war or for sampling at the height of the Cuban missile crisis was driven by the Air Force's long-standing goal of documenting fallout from the Soviet Union's testing campaign as accurately as possible in order to justify its own policies and budgets. This project has documented the potential stockpiles of fissile material and fallout production through testing that provided AFOAT-1/AFTAC with data on the threat posed by the Soviet Union, under the assumption this information was reported up through the chain of command for use in shaping policy. The emphasis placed in the 4080th SRW October 1962 unit history on high aircraft availability, mission completion, and systems effectiveness rates also reflected the maximum efforts made to keep up with the prodigious quantities of fallout available for sampling from the 1962 test series, more than in any other year.[1182] AFTAC was apparently trying to gather as complete a record as possible under the circumstances in anticipation that this was the final opportunity to so completely document the state of Soviet nuclear art. The United States itself tested nine weapons via air drops or missile shots in October and into early November before its last atmospheric test on 4 November 1962. The Soviets tested sixteen in October alone and twenty-nine more before their last shot on Christmas Day. While testing as a coincidental factor has frequently been noted in histories of the Cuban missile crisis and the role of the U-2 acknowledged as seminal in precipitating it, the secret pursuit of fallout at virtually any cost was indicative of command obsession with what the Air Force saw as the all but incalculable institutional value of fallout. Letting go was difficult for General Power and others, most notably General LeMay, who came to depend on it, along with krypton-85 and the other nuclear intelligence data produced by the AEDS. These radioactive samples and other related findings were substantive talismans that served it well in justifying the enormous budgets required to build and maintain the nuclear Air Force. The cumulative benefits of fallout documented in the data AFTAC produced so assiduously were clear to Air Force leaders. The cumulative risks outlined by the very same data loomed larger in the eyes of others, including at the White House.

1962: Counting the Costs of the Fallout War

In Nevada, the American testing program turned largely underground when the United States initially joined in after resumption of testing by the Soviet Union in 1961.[1183] However, the U.S. continued atmospheric testing of multi-megaton devices in the remote Pacific in a lengthy, final 1962 series. American testing was forced to relocate to the waters surrounding a base on the isolated British possession of Christmas Island, with high altitude shots launched from a U.S. base on Johnston Island.[1184] The Soviets were vague about the end date of their testing even into early December 1962, with the last Soviet atmospheric test taking place on 25

[1182] 4080th SRW, 1962 Unit History, October 1962, 34.

[1183] The exceptions were the four low yield shots associated with the Davy Crockett program and another device, plus the only partially contained peaceful nuclear explosion (PNE), SEDAN (104 kilotons, 6 July 1962), known to have generated a large amount of fallout despite its ostensibly peaceful nature.

[1184] Protest over the use by the United States of Pacific Island trust territory for testing nuclear weapons and the impact fallout had on native populations forced the U.S. to abandon use of the Eniwetok and Bikini atolls for the even more remote British possession of Christmas Island for the 1962 series. Because of its limited land area, nearly all tests conducted there took place as airbursts over the ocean nearby to limit contamination of vital test support facilities. The British gained access to underground testing facilities at Nevada Test Site in return.

December 1962, a relatively modest 8.5 kiloton shot that ended a month of testing with a yield total of ~29.5 megatons. Like much of the discussion of testing by the Soviets, hindsight is roughly 20/20, but it was clear that some information was known quite accurately at the time. The intelligence capabilities available from an early date to the Air Force provided by AFOAT-1/AFTAC appeared to read the actual quantities of the Soviet plutonium stockpile with remarkable accuracy throughout the 1950s and into the 1960s, based on the evidence now available.[1185] It has been assumed for the most part in discussing the estimates AFOAT-1 derived from the MUSIC data here that the president had the best estimates available of the balance of nuclear power with the Soviet Union to shape his decisions; certainly he was informed by advisers of the summaries and conclusions drawn from Soviet stockpile and weapon estimates, if not the detailed relevant reports.

A recent declassification squared this circle, making it clear President Kennedy, and most likely his predecessors Dwight Eisenhower and Harry Truman, were provided with fairly concrete numbers to use in crafting policy to address the Soviet threat. By late 1962, the most immediate Soviet threat was the effect of a wartime weapon that was also experienced even in a time of relative peace – fallout. Presidential advisors kept a close eye on certain significant statistics, including tracking cumulative Soviet testing fallout – as well as that from American testing. In practical terms, GABRIEL was deceased a decade previous, but the one significant question that was its focus lived on in secret – attention to the risk posed by cumulative fallout. Originally conceived as a research question when it was imagined only war itself could bring a large enough expenditure of nuclear weapons to pose a global fallout threat, whatever their real intent the Soviet actions in 1961 and 1962 made clear testing itself could also push fallout to alarming levels.

In the form of a memorandum to National Security Adviser McGeorge Bundy dated 26 December 1962, Deputy National Security Adviser Carl Kaysen laid out the fallout situation as of the moment when the Soviets concluded their most recent, and as it proved last, atmospheric

[1185] Obviously, correlating evidence to assess the performance of AFOAT-1/AFTAC that became available after the end of the Cold War was generally not available at the time. The big exception was the refutation of any bomber or missile "gaps" by U-2 and satellite imagery. Nonetheless, the annual unit histories it produced present the impression that Air Force and national leadership were very satisfied with their investments in the AEDS and the work product it produced.

test series.[1186] Originally accompanied by a draft version of what was anticipated to be Kennedy's rejoinder to an anticipated Soviet announcement of the end of their test series, Kaysen's memo presumably addressed their joint interests in peace prospects at the negotiating table in Geneva. Kaysen offered his own take on the situation, advising Bundy that the White House was aware and tracking the alarming numbers regarding the cumulative yield, thus the fallout, of the massive test series. Kaysen argued they wanted to avoid a congressional backlash over Soviet fallout, which would make any agreement to end the problem that much more difficult to reach. Kaysen hoped taking a "soft line" in addressing the topic would keep the situation in perspective. Kaysen's second paragraph reeled off the numbers. The U.S. tested "69 underground, one under water and 38 atmospheric and space shots. Nine of the 69 have not been publicly announced."[1187] This created the public impression the U.S. conducted some 60 shots over the less than two year period. The remainder of the discussion of U.S. testing was redacted from the document, but context strongly suggested the redaction referred at least in part to the cumulative yield from U.S. testing. Reconstruction from available data indicates the total yield the U.S. expended in post-1960 atmospheric testing was about 31 megatons.[1188]

Kaysen went on to note the U.S. announced all but 26 of the 114 Soviet shots "conducted," thus giving an apparent total of 88 shots.[1189] While the shot totals were not greatly different, despite a clear Soviet numeric lead, the yield totals showed a stunning policy contrast. For the Soviets in 1961, the tests totaled 122 megatons and for 1962, 178 megatons, for a total of 300 megatons over a period of fifteen months.[1190] What compelled the Americans to curtail their own fallout to less than 30 megatons, even as the Soviet Union dramatically ramped-up production of fallout through their own testing? Kaysen's memo was aimed at determining how

[1186] Carl Kaysen, Kaysen Letter for Bundy, 26 December 1962, JFK Library, National Security Files, Subjects: Nuclear Weapons Testing, 8/62-12/62, Box 300.

[1187] This adds up to 108 U.S. shots in 1961-1962. The source most used for this project for historical data on weapons tests is http://www.http://nuclearweaponarchive.org, which indicated 104 shots for this period. Many of the underground shots are listed as "<20" kilotons, which was rounded off to 20 kilotons for consistency purposes here although it was likely many of these shots were well under 20 kiloton yield. Total U.S. yield expended in 1961 and 1962 was approximately 31 megatons. The portion due to aboveground testing was 28.8 megatons.

[1188] http://nuclearweaponarchive.org/index.html.

[1189] Kaysen did not use the more common term "detected" that typically indicated an expression of some uncertainty about the capabilities of the AEDS. Such uncertainty was almost entirely confined to low yield shots, but Kaysen's language suggested this was of relatively less concern to policy makers. Kaysen confirmed the commonsense observation that "what we don't announce is always small."

[1190] Note that the total Soviet yields mentioned in the document do not exactly match retrospective historical totals available now. Intelligence estimates often undergo revision and correction, which is the most likely explanation for the differences.

to spin potential future American testing in light of the Soviet campaign, while creating political space to foster an eventual agreement by seeking to avoid "the kind of Congressional noise we don't particularly want."[1191] The memo confirmed the Pentagon had no need for atmospheric testing until 1964, while the AEC could test in late 1963, but would find it more expeditious to wait until 1964 so the military could support their joint operations.

In arguing for an empirical basis for the decision to end fallout, the overwhelming bulk of the evidence, once brought together and used to frame the evolution of understanding within the government of the Bomb's threat to humanity, indicated in the end the United States government could be taken at its word that it would only act to limit fallout risk if based on scientific knowledge and empirical fact. While it remains unwilling to release the largest, most detailed set of fallout data, it was clear over the first decade and a half of the Cold War the government was forced to repeatedly radically alter its policies to deal with the threat posed by fallout. One need only take the government at its word that it indeed did put an end to fallout from testing as evidence emerged of its threat to human health. While they remained relevant, testing did not end because of public and political pressures brought about by fallout, as vital as those were to reminding the White House about the almost wholly negative public reaction to fallout.

> As knowledge of the nature and effects of fallout increased, and as it became apparent that no region was untouched by radioactive debris, the issue of continued nuclear tests drew widened and intensified public attention.[1192]

While the only definitive answer to this problem can be found in the withheld data, the fact it remains off-limits to research decades after it was applied to evaluate the scientific mettle of Machta's Weather Service model of uneven fallout disposition is highly suggestive there is little chance it supports a benign interpretation of the scope or impact of fallout risks. That fallout creation ended rapidly and in consensus with the Soviets is another factor highly suggestive that, at a minimum, the AFOAT-1/AFTAC data was supportive of a decision to end

[1191] Charles H. Reichardt, Director of [AEC] Intelligence, to Nathan H. Woodruff, Director of Division of Operational Safety, "Fission Yield of Soviet 1962 Tests," National Archives and Record Administration, College Park, Sunshine RG 326.73, AEC Division of Biology and Medicine, Box 11. In a memo very similar to Kaysen's from the White House, Reichardt advises Woodruff, "In view of the White House restriction on the dissemination, as well as public release of information on Soviet tests, it is requested that no dissemination be made of this data without authorization…"

[1192] U.S. Department of State, "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water," http://www.state.gov/t/isn/4797.htm. Although it offers no new or recently declassified data to support its statement, the Department of State probably best sums up the balance between empirical factors and public opinion on fallout that resulted in ratification of the 1963 LTBT.

atmospheric testing. Given the relative American caution in testing that saw it take nearly a decade to break the 60 megaton total yield line originally suggested by GABRIEL, the subsequent Soviet fallout profligacy spike in 1961-1962 effectively more than doubled their fallout contribution over that of the Americans, likely providing additional evidence of the dangers of cumulative fallout from even a relatively limited nuclear war. In almost every important aspect, most trends regarding fallout that were known or at least partially understood by the early sixties were of a problematically negative slope versus the sunny optimism of the fifties promoted by Strauss, Teller, Libby, and others that fallout was a controllable effect. Importantly, while the exact level at which fallout becomes a global problem depends on many factors, the evidence clearly points to the order of magnitude when fallout becomes a global threat as being far closer to GABRIEL's original estimate of 60 megatons than the later, sharply revised estimates of 2,000 megatons of yield or more suggests.

1963: Endgame: Telling Congress Just Enough to Win Support

With testing fallout raining down or otherwise deposited on the heads of those they represented, Congress continued to alternately scorn and support test ban proposals. Senator William Proxmire (D-WI), who personally supported a test ban treaty that was "essential lest mankind in a few years 'simply choke to death on fallout," nonetheless observed if such a proposal was brought to the Senate for ratification, "it would not get the two-thirds support it would require." Columnists argued this was largely because "we won't trust the Russians on such an agreement."[1193] But Congress no longer felt it could trust the reassurance of reports such as that from the Federal Radiation Council, either, apparently deeming the risk of backlash over fallout as a greater potential problem than voting in support of a treaty with the Russians to end it. Senator Paul Douglas (D-IL) demanded "proof" that the U.S. could detect potential cheating by the USSR.[1194] In the end little was publicly said about the means of verification for the treaty, as such reassurances were communicated in secret to Congress. Thus, knowledge of the exceptional work of AFTAC and its predecessors in nuclear intelligence remained hidden from the public and only incompletely known to Congress. This situation persists, with the matter of "trust" hanging over all such agreements with the Soviet Union, then continuing long after the Cold War ended as the apparent primary basis for their enforcement known to the public.

[1193] Harry Golden, "A Singular Plan to Prevent War," *Los Angeles Times*, 8 May 1963.
[1194] Robert Albright, "Test Ban Defeat Seen if Senate Voted Now," *Los Angeles Times*, 18 May 1963.

At the time, Senator Thomas Dodd (D-CT) – a long-time critic of arms control – was compelled by public opposition to fallout to adapt his position so that it would conform to the constraints placed on nuclear weapons by it. By calling for an end to atmospheric and underwater testing, a position that was increasingly seen as the solution to ending fallout, Dodd's shift opened the way for the legislative compromise necessary for the Limited Test Ban Treaty to achieve ratification in the Senate. Although the exact means and methods of detecting potential Soviet cheating remained concealed, the political elites represented in the Senate were apparently satisfied the United States possessed the capability to reliably detect Soviet violations.[1195]

[1195] William S. White, "Sen. Dodd and Co. Help to Clear the Air on Nuclear Test Ban Issue;" "Getting Off the Nuclear Hook;" both *Los Angeles Times*, 31 May 1963.

Chapter Six: Conclusions – There Is Still Time

Taking the Temperature of Real and Imagined Wars

[in the war room, Dr. Strangelove]

Soviet Ambassador DeSadesky:

A lethal cloud of radioactivity…will encircle the earth…

U.S. General Turgidson:

Ah, what a load of commie bull…[1196]

Benjamin P. Greene was correct to urge historians to give attention to an increased role for science in shaping Eisenhower's anxieties over the military industrial complex. Arguably, there was no clearer marker of Ike's disappointment with scientific advice from the Strauss-led AEC than his stubborn insistence that, after putting its chair out to pasture, whatever way forward that came about from the Geneva process must put an end to fallout.[1197] Does a clear statement of this quid pro quo exist? Perhaps, but it was nonetheless implicit in the policies Eisenhower adopted. The facts, context, and totality of knowledge about fallout present only with Eisenhower, a select few in the Pentagon and shared among even fewer key presidential science advisers played out in the hands of a man well aware of how the political ramifications of public sensitivities over fallout could deliver a crippling blow to faith in nuclear weapons as a means to ensure national security. It was knowledge he shared with his successor, yet this knowledge also offered no easy alternatives. Widespread evidence of how fallout acted socially and psychologically on ordinary citizens has been covered by researchers across the spectrum, from Miller to Weart to Tannenwald. Leadership elites, obviously imperfectly, sought to allay the fears of ordinary citizens about fallout, but even the most basic materials to reconstruct their contextualized motivations and actions necessary to provide better insight into their actions remained mostly inaccessible until recently. Irrational fears may drive some of our perceptions of nuclear power, but marked tolerance for nuclear weapons remains driven largely by our carefully cultivated ignorance about the risks posed by fallout in the event of a nuclear war.

By the mid-1950s, fallout's secret utility as a vital intelligence resource was increasingly undermined by recognition it was a public, yet carefully concealed strategic liability of nuclear

[1196] *Dr. Strangelove (or, How I Learned to Stop Worrying and Love the Bomb)*, Stanley Kubrick, 1964 (102 minutes).

[1197] It should be emphasized again Eisenhower absolutely wanted more than an end to fallout. His goal was a comprehensive ban on all nuclear tests. But it is all but certain based on the evidence that Eisenhower came to regard an end to fallout as the minimal goal he sought to achieve in the Geneva negotiations.

weapons. This transformation suggests the historiography of fallout would benefit by re-centering from the current model analyzing its effects as primarily a psycho-social matter of fearful perceptions into a more comprehensive model that includes its study as an empirical phenomenon that sparked a fundamental crisis of strategy throughout Dwight Eisenhower's administration. In its most manipulative form, the fundamental reason for persistence of secrecy about fallout was to preserve the perception of a need for a vast nuclear stockpile that coincidentally sustains the threat their cumulative fallout poses to our only planet. Massive use of these weapons would substantially alter life as we know it, those infamous words, probed so thoroughly in 1954 even as the fundamental reason for that topic to arise – fallout – could not be mentioned. The effective operational military requirement to ensure deterrence is probably closer to just dozens of weapons, rather than the thousands of weapons still in service, in order to avoid risking politically and environmentally, if not genetically and medically intolerable levels of fallout.[1198]

The real secret to fallout, in the past and on into the present, was never simply confined its own narrative, but the light it threw on a national security strategy top-heavy with nuclear weapons. Fallout fundamentally called into question the U.S. military's dependence on the deterrent effects of weapons in numbers they dare not use except under the most extreme duress. Many subject matter experts suggest nuclear weapons made the Cold War conflict a game of chess. Fallout's story suggests it was more akin to the far simpler game of Russian roulette, perhaps better termed now as Russian-American roulette, but played with only one chamber empty; who dares go first? In the end, it was not so surprising to find political and military elites conceding an end to fallout because it represented a threatening, even a potentially fatal blow to popular faith in the central technological achievement of the nation-state in the twentieth-century, nuclear weapons. Nuclear weapons remain as iconic tokens of power, but any other costly weapon so lacking in military utility would have been retired long ago.

Long-eluding examination by dint of its classification, declassification continues to yield a growing body of evidence that fallout undermined the fundamental basis of national security policy based on nuclear weapons. A significant trove of empirical evidence about fallout's role in underwriting the policy changes its uncertain risks brought about exists just out of reach. It is

[1198] It is important to point out this argument specifically is not one in favor of making it more possible to conceive of nuclear weapons having practical use. Rather, it is a point about the wisdom and need to confine the consequences of their use if commonsense ever fails humankind.

important to keep in mind, as with the Oppenheimer case, fallout was often not permitted to appear in certain documentary contexts despite being intimately connected to what was recorded. Historians have been patient, but also must begin to describe as best they can what we know must be on the few pieces that appear to be intentionally missing from this puzzle, but which nonetheless can be outlined and clearly communicated in general terms through interpretation of their surrounding factual basis in Cold War narratives that remain subject to extraordinary classification regimes.

Besides the new insights developed in inquiring about the missing fallout in the Oppenheimer case, among the most telling observations was the direct line of rough correlation that connected GABRIEL's 60 megaton limit from a time when only fission weapons existed to evidence of its continuing constraint on the American nuclear weapons program. Total fallout from testing hewed relatively closely to that 60 megaton figure up until the end of the CASTLE thermonuclear series, a test program planned by the same Oppenheimer-led GAC that expressed concerns about pursuing the hydrogen bomb that this project argues were based in significant part on the potential threat posed by their fallout. Whether documentary evidence exists to support a connection remains unknown, but is among the many questions suggested by applying the known history of fallout in search of a more frank Cold War history. Subsequent to the 1954 BRAVO fallout incident, fallout "budgets" were imposed, if not always strictly observed, in order to limit total fission yield of each series.[1199] Strictly speaking, the United States did not exceed 60 megatons of fission yield aloft at any time. Only the 48 megaton total fission + fusion yield of the CASTLE series even approached the 60 megaton limit. The 10 megaton annual limit on fission product additions to the atmosphere the AEC announced in 1957 thereafter ensured fallout aloft stayed well under the 60 megaton limit conceptualized and calculated in GABRIEL. Correlation is not causation, but general insights can be drawn from the known facts. In spite of enormous pressures to test more, higher yield weapons, the American observance of this shadowy standard clearly was effectual because of the resulting CROWFLIGHT and other data that supported the low end of GABRIEL's range of estimates as cautionary in practice, as well as

[1199] The existence of a previous fallout budget up to that point would entail some discussion about the rationale for it, inevitably making it exactly the sort of thing that could not be discussed when the term itself was forbidden. The distinction between fission and fusion fallout is crucial. This is not to say that fusion results in a "clean" weapon as many were led to believe. But the key here is that fission reactions produce the bulk of the dangerous long-lived fallout, a distinction that was made by the AEC in the nineteen-fifties, but often not understood in terms of evaluating and interpreting fallout totals.

in theory. The portent of fallout contamination from testing showing up in the food supply at levels the government defined as troubling can remain subject to various interpretations of risk, but its factual existence and political impact cannot be denied. Only the foolhardy would now suggest any appetite for exploring life as we know it, plus thousands of megatons of fallout yield, as a justification for targeting others for any cause, since nuclear nations who did so would be so surely targeting their own populations.

Eisenhower's decision to commit to an atmospheric test ban was initiated by fallout's contamination of American wheat in the upper Midwest in 1959.[1200] Delayed in application by diplomatic contingencies, it was a decision upheld by the subsequent Kennedy administration against great odds once the restart of atmospheric testing brought on an even more acute crisis of iodine-131 contamination in milk. In that sense the decision to end of fallout came just a decade after the Soviet Union demonstrated nuclear capability, rather than the fourteen years it took until formal ratification of the 1963 Limited Test Ban Treaty.

Nearly Conclusive[1201]

The 1964 contest between President Lyndon Baines Johnson and Senator Barry Goldwater capped a decade of change in fallout's meaning following the CASTLE BRAVO incident. Goldwater's unrestrained enthusiasm sought to keep the myth of nuclear weapons as a useful instrument of national policy alive, but also made him the target of Johnson campaign commercial that ran just once. A girl plucked petals from a daisy, then her innocent schoolyard chant morphed into a countdown to a nuclear explosion.[1202] A little over a week after it showed, and then was quickly pulled from the air, the president spoke at a dinner in Seattle, using the occasion to drive home the point – rejecting such ideas as conventionalization, Johnson argued fallout rendered nuclear war all but unthinkable, invoking an obvious reference to the cumulative

---

[1200] The scare over contamination of wheat by fallout as Eisenhower's last term ran out affected basic staples of the American diet, a far more frequent contact with radiation than making a decision about whether or not to build a fallout shelter. This suggests that the humble bread wrapper or milk bottle might be a better locale of analysis for fallout than such relatively rare curiosities as the fallout shelter.

[1201] While the 1963 Limited Test Ban Treaty between the United States, Soviet Union, and United Kingdom ended fallout from the first three nuclear powers, France proceeded with its far more modest testing, begun in 1960, until it ended the practice in 1974. The People's Republic of China began atmospheric testing in 1964, continuing until 1980. China's 16 October 1980 test was the last atmospheric test by any nation. Others who "join the nuclear club" now go underground immediately in order to limit the revealing data recorded by AFTAC and the multinational International Monitoring System under construction and testing by the Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organization, http://www.ctbto.org/specials/who-we-are/.

[1202] The commercial played just once, on 7 September 1964, but was then seen repeatedly in coverage of the Goldwater campaign's protest of the Johnson ad's negativity. It is available at the Museum of the Moving Image's website: http://www.livingroomcandidate.org/commercials/1964/peace-little-girl-daisy radiation effects produced by hundreds if not thousands of weapons detonated in a short period of time.

> Let no one think atomic weapons are simply bigger and more destructive than other weapons…A cloud of deadly radiation would drift and destroy, menacing every living thing on God's earth, and in those unimaginable hours unborn generations would forever be lamed.[1203]

Johnson noted that every American president since the bomb was unleashed drew the same conclusion, even if others had not specifically cited fallout to the public as the most significant reason why nuclear war was something to be avoided, not embraced. It was unclear if Johnson's vision of a "cloud of deadly radiation" was prompted by the cultural influence of Ambassador DeSadesky's reminder to General Turgidson that a "cloud of deadly radiation would drift and destroy" the world, a poignant scene depicted in *Dr. Strangelove* following its January 1964 release. It was clear this horrendous image of a fallout-shrouded world represented an overwhelming counterbalance to the seeming utility of nuclear weapons, not simply a misperception of the threat they posed. The hidden hand of fallout shaped the contextual reality that structured Cold War culture. Politically and personally, citizen-consumers largely refused to buy into it once fallout was no longer a deniable secret. By 1964, fallout clearly constrained the national security policy choices available to political leaders, limited the utility of nuclear weapons on the battlefield, and shaped the political fortunes of those who engaged with it. Fallout could not in itself eliminate nuclear weapons, but knowledge of its inevitable threat made contemplating their use nearly impossible.

While fear of fallout has retreated from the vanguard of public anxieties, the best evidence of its explicit empirical role in limiting perceptions of the utility of nuclear weapons remains locked behind closed doors. This "gap" perpetuates a telling ignorance about the Cold War capabilities of the U.S. nuclear intelligence program, as well as about the dubious prospects of anything like "victory" in a nuclear war. This missing Cold War history lesson, where empirical factors played a predominant role in ending fallout by secretly, fundamentally augmenting the external political pressures brought on by popular mobilizations in opposition to the nuclear weapons is one the public and their representatives need in order to construct wise

[1203] Lyndon B. Johnson, "Remarks in Seattle on the Control of Nuclear weapons," in *Public Papers of the Presidents of the United States Lyndon B. Johnson Containing the Public Messages, Speeches, and Statement of the President 1963-1964, Book II* (Washington, DC: U.S. Government Printing Office, 1965), 1078-1081.

national security policy. Ignorance on these matters accounts for why diplomatic agreements and the well-proven arms control verification capabilities that support them often remain political shuttlecocks at the whim of the Senate. Writing in the always relevant *Bulletin of the Atomic Scientists*, Robert Nelson recently observed the 1999 Senate vote rejecting the CTBT's ratification was based on an "opposition [that] mainly was driven by ill-founded concerns that the treaty was not sufficiently verifiable."[1204] Relating this narrative is crucial to begin removing the political stumbling blocks such manipulative ignorance poses to efforts to ratify the Comprehensive Test Ban Treaty and undertake other arms control measures that can be managed by the robust detection and verification capabilities honed by AFTAC over decades of effective and successful operation.[1205] The role fallout played in establishing the vigorous Atomic Energy Detection System, making the 1963 Limited Test Ban Treaty eminently verifiable, was matched by fallout's role in sparking science that provided technology to globally detect any nuclear explosion down to less than one kiloton, even when its fallout was contained underground. Knowledge of this consequential past is vital to a peaceful future.

Conclusion

It is risky to make assumptions about secrecy, yet it is a very rare history that proceeds without an array of small assumptions to color in between what is known with certainty. This conclusion is not dependent on the following assumption, even as the evidence points in this useful direction. If the trove of data represented by the massive fallout created in 1961 and 1962 and collected by AFTAC provided exculpatory evidence that demonstrated a relatively limited risk posed by fallout, it would have been quite unlikely to still be secret and unexamined by third parties at this late date.[1206] A 2003 follow-up review report by the National Academies of Science suggested efforts continue to identify and preserve relevant documents, while striving to "[e]nroll other government agencies, especially the Department of Defense, in the effort to

1204 Robert Nelson, "3 Reasons Why the U.S. Senate Should Ratify the Test Ban Treaty," *Bulletin of the Atomic Scientists*, Vol. 65, No. 2 (March/April 2009), 52-58.

1205 AFTAC is the operator of the United States National Data Center, the main point of contact and coordination between the United States government and the Comprehensive Test Ban Treaty Organization. Some, but not all of AFTAC's sensor networks are included in the International Monitoring System that the CTBTO operates on behalf of CTBT signatories. See: U.S. National Data Center, http://www.usandc.gov/.

1206 Centers for Disease Control and National Cancer Institute, *Report on the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations*; the 2001 report and additional information are linked from: http://www.cdc.gov/nceh/radiation/fallout/. This report indicated these institutions required the better data set still held secret by the Department of Defense in order to best assess the nature and extent of damage due to fallout. Fifteen years later, this request remains unfulfilled.

identify, preserve and publish information."[1207] Progress on this, if any, suggests the silence will continue. Given the passage of time, holding the materials to at least the natural lifespans of anyone alive during the era of atmospheric testing may be the goal. Such a result would largely frustrate attempts to relate the data to subsequent health outcomes at the individual level; it may not prevent epidemiological studies of cancer incidence. Perhaps fear of motivating legal or political action is the fundamental threat to national security implicit in the need to keep these materials classified and unavailable to researchers? Perhaps. More likely, it is at least as much fear of the budget impacts on a nuclear force still struggling to maintain relevance a quarter-century after the end of the Cold War. If many in Congress are still trying to fight the last war, it should be no surprise that the Pentagon does, too, while failing to prepare to better meet future national security needs.

Fallout provides a "hidden transcript" of the Cold War that refashions a conventional narrative of a predominant American empire into one that is not just politically, but empirically far more ambiguous in terms of its dimensions than those posited by post-Cold War triumphalism about the "end of history."[1208] This partial transcript of fallout's work was replicated "onstage" through the performances of the powerful, although "almost always in disguised form" to the vast majority of citizens.[1209] Social actors found their actions constrained by it, but in the absence of war, only rarely directly impeded by fallout; yet political and military leaders were obviously forced to take it into account in making their decisions about a host of national security policy problems. In the same vein, fallout forced choices on consumers, whose reaction foretold the failure of any policy reliant on self-mobilization, like fallout shelters. Against a threat most saw as unlikely, but inevitably world-shattering if it did occur, they nonetheless endured a foretaste of it in the anxieties fallout from testing imposed on their lives. It was hard to get to "Sold" in fallout shelter sales, despite claims by Eisenhower that his policies

---

[1207] Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council, *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations* (Washington, DC: The National Academies Press, 2003), 36.

[1208] Given the long half-lives of some isotopes, fallout is a reminder that Cold War history is far from being "over" while it continues to affect the lives of untold numbers of global citizens.

[1209] Robin D.G. Kelley, *Race Rebels: Culture, Politics, and the Black Working Class* (New York: Free Press, 1996), 7-8.

resulted in “construction of over one million family fallout shelters.”[1210] The more they knew about the nuclear-enhanced version of national security, the less citizens and consumers were willing to buy in to such policy.

Thus Eisenhower’s alarm about fallout, a wartime nuclear weapons effect that also occurred in peacetime due to testing, was directly related to his alarm at the idea of general nuclear war, an enormous disquiet the president shared with most Americans, indeed with most across the globe because of fallout’s inherently transnational nature.

Superficially, fallout was also a major contributor to the paradoxical toxic brew of belief that deterrence represented a stable solution by dint of its capacity to leverage the power of thousands of weapons to dampen belligerent tendencies. Fortuitously, fallout became strongest in its effects during times of crisis as the prospect of confronting it loomed in the windshield. Paradoxically, fallout also acted to corrode the stability it seemed to provide to the deterrent value of nuclear weapons, because its threat undermined the credibility of their use. Deterrence depends on certainty; fallout made the potential response less certain, even more so in the numbers of deployed weapons standing at alert achieved by the mid-sixties. This fear of fallout’s creating hesitancy to use nuclear weapons kept those involved with the Oppenheimer hearing silent about it, including the famous scientist himself. Hesitancy became the crux of the problem of the strategic impasse represented by thousands of nuclear weapons; their existence continued even as the passions that drove their acquisition faded and the burdensome and limited utility they provided came into better focus. Nuclear weapons seductively provided a supportive basis of seeming stability to address national security concerns; at the same time, underneath this fragile crust, fallout lurked as a bottomless quicksand of despair and doubt in their effectiveness. Other than roping off this area with secrecy, by the late nineteen-fifties, the U.S. government concluded it had only one option to avoid significant constraints on its policies because of what

[1210] Memo to Leo Hoegh from Dwight D. Eisenhower, 29 December 1960, Eisenhower Library, Ann Whitman File, Administration, Box 19; Kenneth D. Rose, *One Nation Underground: The Fallout Shelter in American Culture* (New York: New York University Press, 2001), 187, 201-202, 206. Statistics on actual fallout shelter construction suggest Americans were overwhelmingly reluctant to invest in them. Just 0.4% indicated they were “taking steps” to build a shelter in one 1962 study. Early in the Kennedy administration, a 1961 survey of governors indicated there were about 60,000 built or planned. A 1965 estimate placed private shelters as high as 200,000 in 1965, but at one shelter per 266 households, a lot of Americans clearly were not enthused about or investing in even the most minimal shelters. By 1967, some 160 million spaces in public buildings were supposedly identified and marked; many, if not most, were never stocked with supplies like water and emergency rations.

was publicly available and known about nuclear weapons – quit testing that created fallout in the atmosphere.

Eisenhower and Kennedy understood well what was afoot, even when few others inside or outside their administrations were in position to see all of what was at stake because of fallout's extensive insinuation into national security policy. Preserving the reassuring appearance of seemingly deterrent nuclear weapons sought to disguise a pit of public relations fallout/lava looming underneath, which festered in the face of national political leadership that beyond the apex of the executive branch did not fully understand the implications of fallout. With the Cold War long over and new political fears occupying the attention formerly given to far more consequential terrors, what is the president told now about fallout's impact on his or her decision making if the time should ever come when that choice is thrust at them? In a sense, being oblique about fallout is way for the military to reassure the hand poised near the "button" that everything has been taken into consideration in choosing nuclear war as the best option among the bad. As J. Robert Oppenheimer reminded in 1950, it is not so simple.

> It is a grave danger for us that these decisions are taken on the basis of facts held secret…The facts, the relevant facts, are of little use to an enemy, yet they are fundamental to an understanding of the issues of policy. If we are guided by fear alone, we will fail in this time of crisis.[1211]

Moreover, in a still unstable world, with far too many nuclear weapons out there, as well as those who persist in aspiring to make their own, more effort is badly needed on reducing the scope of destruction from a future failure of deterrence by emphasizing continued reduction in overall arsenal inventories among the nuclear states, as well as preventing further nuclear proliferation.[1212] Given existing geo-political realities, there will be more than enough weapons available for a fine little war for decades to come. Drastic measures are needed to significantly reduce the threat of catastrophic mass nuclear exchanges that can serve no purpose beyond irreversibly damaging the planetary ecology, human health, and the common genetic legacy of Earth. The best opportunity to do that may already have been missed in the quarter century since

---

[1211] J. Robert Oppenheimer, 12 February 1950, radio show interview with Eleanor Roosevelt, reproduced in U.S. Atomic Energy Commission, Forward by Phillip M. Stern, *In the Matter of J. Robert Oppenheimer: Transcript of Hearing before Personnel Security Board and Texts of Principal Documents and Letters* (Cambridge: MIT Press, 1971), 962.

[1212] The United States is a signatory to the 1969 Non-Proliferation Treaty. The non-nuclear signatories pledged to not pursue weapons program in exchange with the nuclear weapons-holding states aiding them with peaceful applications of nuclear energy and pledging to pursue nuclear disarmament. That pledge remains notably unfulfilled even as the non-nuclear signatories for the most part have faithfully honored their commitments.

the end of the Cold War. The danger fallout continues to pose remains a cumulative one. The only truly effective means of treating this threat are the sorts of reductions in frontline arsenals that limit the possibility any power could see an advantage in preemptively attacking others with nuclear weapons. In case of such verifiable reductions, fallout would tend to strengthen the deterrent impact of the remaining weapons by making their use more credible in extenuating circumstances. Yet, this, too, is an uncomfortable argument to make in a world better off entirely without such weapons – where less is more – and unlikely a goal that can be achieved in this century. Education about how cumulative fallout makes use of nuclear weapons an implausible and suicidal scheme is an achievable goal, as well as a prerequisite in saving humanity from its own worst urges. Progress depends in part on changing the public perception of nuclear weapons from the ultimate weapon some prefer to see into the reality of failure their military utility represents.

The hold of "terrorism" and its retail level threats on the political imagination pales in comparison to the elephant in the room of threats to the political order engendered by the looming prospect of massive fallout amid the destruction of a general nuclear war. The extraordinarily successful efforts of AFOAT-1/AFTAC should discourage any who might seek to acquire nuclear weapons from believing a nuclear weapons program can ever really be hidden. The full record of fallout's secret life must one day become public in order to facilitate such conversations. Fallout sampling is just one among a number of relevant techniques developed so that any tree falling in the nuclear forest, no matter how small or far away, will attract the attention of the world.

Oppenheimer's Vindication: Hearing Now Seemingly without Explanation

The Oppenheimer case was rendered far more complex than familiar by attending to its numerous intersections with fallout. The recently declassified and now nearly complete transcript of the 1954 hearing serves as a reminder fallout was a rather more significant and substantive issue in this matter, but remained largely concealed within the smokescreen of a political loyalty narrative that has drawn so much study over the last six decades.

The 12 October 2014 *New York Times* headline read "Transcripts Kept Secret for 60 Years Bolster Defense of Oppenheimer's Loyalty." Declassification by the Energy Department of a batch of thousands of pages of testimony and other evidence redacted from the trial records used in this project appeared to conclusively set aside the basis the trial was publicly premised upon, as well as the central focus for historians in its aftermath, the question of J. Robert Oppenheimer's loyalty. Richard Rhodes spoke directly to one of the premises of this project; Oppenheimer's abiding belief low-yield tactical weapons should be prioritized over high-yield thermonuclear weapons.

> "Oppenheimer was worried about war on the ground in Europe," Mr. Rhodes said in an interview. He saw the need for "a large stockpile of fission weapons that could be used to turn back a Soviet ground assault…" the security board found that Oppenheimer's early views on the hydrogen bomb "had an adverse effect on recruitment of scientists and the progress of the scientific effort."[1213]

Left unanswered was what those "early views" were. If loyalty was not the answer and their cumulative fallout was the major problem Oppenheimer saw with thermonuclear weapons, then the answer to that question seems starkly obvious, based on the evidence here. The scientist's conflict with General Curtis LeMay over the nature and scope of Air Force war plans was driven by the fact the general countenanced no limits on the use of thermonuclear weapons. The primary reason Oppenheimer objected to what he termed the Air Force's "goddamnedest" plans for employment of these weapons was not fallout, per se, which he accepted as a limiting factor in the use of nuclear weapons, but not a bar to it, but reckless disregard for the cumulative threat posed by using these weapons in an unrestricted manner. He also encouraged research to answer basic questions about the global threat fallout posed if not managed carefully. Project GABRIEL promised to eclipse the value of what was learned from Willard Libby's Project Sunshine and is likely the best lead to further unearthing the parameters of empirical risk that appeared to guide American atmospheric testing and the decision to end it. Essentially, the threat fallout posed to the global environment and human health from the massed employment of nuclear weapons as contemplated in SAC war plans meant that all but a relative handful of these weapons in the American stockpile lacked substantial and effective military utility despite their impressive yields.

While this project can answer some of the questions raised by taking loyalty off the table as the source of the attacks on Oppenheimer, it remains at best a second draft of a history just now coming into view. As with some aspects of this effort, there are passages where informed speculation is reasonable, given how clearly contingency, ideology, science and revelations

[1213] William J. Broad, "Transcripts Kept Secret for 60 Years Bolster Defense of Oppenheimer's Loyalty," *New York Times*, 12 October 2014.

about adjacent secrets all significantly narrow the possibilities of what decisions were made by who and why, as well as to account for places where events and facts beyond control of human actors shaped the choices and constraints they faced. What is on that missing puzzle piece can be described with considerable accuracy, if not yet with complete certainty. A new Cold War narrative where Russian capabilities were much better known, earlier, is balanced off against the Air Force's pursuit of its institutional interests as much as the national interest and a largely hidden, still fundamentally misunderstood analytical intelligence failure better known as the bomber and missile "gaps." This project helps close the "fallout gap" in Cold War history, perhaps the era's least understood, but most important remaining systemic intelligence secret.

Drawing Conclusions

Beyond the stark lessons fallout's history should teach are conclusions that are more subjective. Given previous rows over who owns the history of Hiroshima and Nagasaki and other Cold War narratives, a writer and researcher cannot help but be cautious with the evidence while being forthright about the need to draw obvious conclusions from it.

. Was the 1954 hearing that sent Oppenheimer to the street the purely political hatchet job many on the left believed it to be? Politics were certainly involved, but the truth was a far more complex matter. Was Oppenheimer disloyal or attempting to destroy the Strategic Air Command as conservatives have often insisted? Those charges have all the substance of a smokescreen, which is exactly what they were. Fundamentally, the Air Force was out to protect the most important intelligence system most American have never heard of, the Atomic Energy Detection System, operated by obscure Air Force units with even more obscure acronyms. Air Force Technical Applications Center continues the outstanding legacy of an organization that reinvented itself several times, but has always remained unfortunately, perhaps permanently relevant. Paradoxically, the Air Force was also willing to sacrifice some part of the secrecy shrouding the AEDS for something even more important – keeping fallout out of the discussion at the 1954 hearing. In roughly 3,000 pages, the long-classified and nearly complete transcript did not record the term fallout even once. Fallout was certainly discussed, but saying it was rather obviously forbidden. There is no other reasonable explanation for this omission, given the subject matter examined at length in it. With only somewhat less certainty, the project argues that fallout points to why the hearing was held.

Ultimately, and somewhat mysteriously, it was someone in the Air Force who pulled the plug on fallout – or ordered AFOAT-1 to do so by cooperating with the Weather Bureau and the AEC in order to get to the bottom of the issues Lester Machta raised about residence time and uneven distribution of fallout debris in the environment. For those who believe this project is intended to smear the Air Force, this is hardly a conclusion that fits with that theory. Whatever the cause was, it was a remarkable change and one quite unlikely to have been inspired by public pressures to end fallout. The Air Force was and remains a remarkably data-driven organization, although one that is quite conscious of how data shapes a debate. Arguably, this is among the more substantive speculations present here. Speculation because there is no document pointing directly at this conclusion, but substantial in demanding something credible that would alternatively explain the policy change more substantially than this does in order to argue against this conclusion. If fallout was the lifeblood of the Air Force that I argue General Power claimed it was, 1958 meant plenty of breathing room and data before the ban caused Power to complain he was having trouble breathing in 1959. Like a number of outcomes here, that the Air Force embraced an end to atmospheric testing was as surprising a result as many others during the course of this research, including discovering Eisenhower's dogged, personal commitment to a more peaceful future.

It was Lester Machta who was a hero here, if anyone were to make the case for exemplary effort. Thrust into the storm by luck of the draw and a modest ambition to earn a living doing science he enjoyed, Machta found himself at the center of one of the most confounding scientific quandaries of the twentieth-century – what happened to all that fallout? The research question itself was born of intelligence needs, because accounting for the bulk of a test shot's fallout provided useful insights otherwise unobtainable in the days before computer modeling could provide them. Tracing the many paths fallout took opened up atmospheric sciences in much the same way that seismology found sustenance in the greatly expanded AFTAC seismic detection program that began in the late 1950s. Machta's decision to go head-to-head with soon-to-be Nobel laureate Willard Libby over the non-uniformity of stratospheric fallout and the failure of Libby's theory of stratospheric residence to account for fallout's recirculation knocked the last props away from the failing model of atmospheric testing.[1214] In

[1214] "Summary: Estimate of Long Term Effects of Fallout from Fission Products from High Yield Nuclear Weapons," 15 September 1955, NARA College Park, SEC, Division of Biology and Medicine, Project Sunshine, the end, it was Machta's data-driven argument that fallout deposition was concentrated over the most populous areas of the United States by stratospheric circulation that seems to have won the day. It is hard to trump data, so Machta's approach turned out to be notably more successful than either Oppenheimer's – or Hedley Marston's for that matter. In an age before whistleblower's found public acclaim, before Daniel Ellsberg and the Pentagon Papers, fallout inspired courage in speaking truth to frightening power.

Still, this narrative of what really happened with fallout in the years from 1945 onward can also satisfy at least the curiosity of those on the other side of the field. The anonymous Air Force boosters of "The Clean Weapons Problem" from 1959 spoke to what might have been secret just a few years before – Or perhaps only Robert Oppenheimer could not say it? – which by 1959 was clearly common knowledge among Air Force officers and, most likely, officers in the other military branches.[1215] This wider knowledge of fallout as a limit, if not always completely accurate and largely withheld as official confirmation of public fears, did confide much about the basic facts, while downplaying the meaning of a marked reversal in national security policy. Official or not, this was partly a result of the outreach the military itself did beginning in 1957 in explaining fallout, as well as was possible by simply reading the papers.[1216] Fallout represented a basic problem of nuclear warfare quite unlike the effects of conventional weapons, a fact that quickly became all but impossible to explain away. Five years after Robert Oppenheimer's involuntary retirement from this important debate, this formerly secret fact was being published, if not quite openly attributed to its author, in the military press.

As with any project of this extent, there will be room for criticism, even quibbling over details of interpretation. But the general conclusions established from the evidence presented herein are fundamentally the same as far less critical Air Force boosters reached in 1959 based on simply being briefed about the situation. More than half a century later, this suggests a search for solutions to the national security problems fallout created that essentially hobbled the

RG 326.73. One of the unanswered questions here is whether the uniformity of deposition that Libby insisted occurred despite Machta and Fine's data showing significant non-uniformity was something inherited from the original British work at Harwell or something Libby hypothesized himself. This unattributed 1955 paper from the AEC's Sunshine files argued that strontium-90 deposition was uniformly distributed for the most part except where surface bursts might keep the plume in the troposphere leading to more intense close-in fallout. Records of the proceedings of the 13 January 1954 AEC Conference on Radiotoxicity of Strontium held in Washington, DC may enlighten on this and other questions, including what the AEC expected of fallout from its upcoming CASTLE BRAVO test.

[1215] "The Clean Weapons Problem," *Air Force*, Vol. 42, No. 12 (December 1959), 36-37.

[1216] AFOAT-1, 1957 Unit History.

American military's dependence on nuclear weapons remains an important and sorely neglected subject of considerable importance, historically and currently. Maintenance of effective deterrence requires a relatively small number of weapons. The current continuing maintenance of sizable, even bloated inventories of nuclear weapons undermines the certainties sought from pursuing deterrence, while making possible the destruction of the world as we know it through cumulative fallout. While there may still be time, time is something that the wise make good use of. It is hoped this account contributes to greater understanding and wisdom about the threat posed by fallout to humankind's future – and how fallout as a secret shaped a historical past that is still not past.

Fallout's story also reminds that policy based on subterfuge of the intellectual process is essentially heavier-than-air; once the energy runs out, the contraption crashes. Factually-based, scientifically valid policy is like gravity, needing no outside energy to sustain a very inevitable pull. Surprisingly more than a half-century after the ending scenes of *On the Beach* reminded there is still time, there is still time to alter the socio-political calculations that blithely accept the inevitably of fallout by accepting that all past choices made on nuclear weapons were either wise or final, that insist there is no choice but to live with far too many of these horrid things as the price of security. That price is far too high for something that undermines national and personal security at least as much as supports it. Understanding fallout's role during the Cold War is the first step to understanding the practical need to avoid nuclear war. To be sure, from such wisdom comes hesitancy, but there is no better way out of the labyrinth that otherwise ends in nuclear war should less wise leaders ever get access to such weapons.

Appendix A: Nuclear Intelligence 101

Nuclear intelligence operations rely on a variety of sophisticated techniques, which were often at the cutting edge of science during the era they were adopted. However, many of the basic concepts of the most commonly used techniques were rather straightforward in explanation, if somewhat more complex in execution. Nuclear intelligence efforts in the 1950s grew to include thousands of personnel scattered around the world at dozens of detachments and associated supporting units, many in remote locations. This point was a reminder that secrecy about processes used for gathering and compiling nuclear intelligence was often employed more as a matter of avoiding confirming the obvious to reasonably well-informed observer-citizens and politicians than it was about concealing arcane knowledge from potential threat nations.[1217] As noted in the text, British-born Soviet spy Kim Philby, masquerading as the MI6 liaison to Washington DC, gained basic knowledge of AFOAT-1 operations when briefed by American security officials on the detection of Joe-1 in September 1949. Although the exact timing of when Philby passed this extraordinarily sensitive material to his Russian intelligence handlers and what he revealed remain uncertain, there was no doubt American intelligence agencies were aware the Russians understood fallout's tell-tale nature. What was far less clear was why that same knowledge initially prompted little effort by the United States to conceal its own testing beyond token measures like the inland location of the Nevada Test Site and patrolling the waters near the Pacific Proving Grounds for Russian intruders.

Aerial sampling of fallout isotopes is still considered to be the one method whose results provide unambiguous indications a nuclear explosion has taken place. With the Air Force's fleet of dedicated samplers in the 1990s hovering around just one airframe, then none, AFTAC maintains fly-away kits allowing rapid field modification of KC-135 and other available or suitable aircraft to provide aerial sampling platforms.[1218] Several other airframes continue to be

---

[1217] While not a student of hard science, as an undergraduate armed with a couple of clues found in the press, a theory, and a couple of beer-enabled physics students to bounce ideas off of, the author was able to determine the basic radiochemistry of nuclear intelligence in less than an hour. That discussion became the basis for the original version of Appendix A from Lehman, 2003.

[1218] William B. Scott, "USAF Nuclear Detectives Assume New Roles," *Aviation Week & Space Technology*, 3 November 1997, 50-53; "Debris Collection Reverts to Ground Sites," 57-59. According to accounts in the press, the last AFTAC-mission dedicated sampler aircraft was retired in 1997. However, given the changes brought about by the "global war on terrorism" and the concerns over concealed weapons programs in Iran and North Korean, AFTAC likely has regular access to one or more airframes as sampling platforms. A public silence on the issue would fit with historical precedents. Likewise, a variety of sampling kits likely offer AFTAC the option of configuring a diverse set of aircraft to provide both mission flexibility and covert operational capabilities.

similarly supported for use as samplers, likely including the venerable U-2 with its unique high altitude capability. With close attention continuing on several nations' nuclear programs, including North Korea's, retention of several options for capturing "hot" samples at various distances and altitudes remains an important part of AFTAC's capabilities.

Fallout sampling was considered the most reliable technique used by the Air Force during the period of intense atmospheric testing. Analysis of fallout samples covers a broad category of distinct radiochemical protocols for each isotope of potential intelligence interest, providing weapons design information, fissile material origin, and other assessments of the qualities of the source device by drawing on its microscopic debris, usually captured on specially treated filter paper.[1219] Gaseous samples capture another range of isotopes in bottles using high-speed compressors. The goal was to describe the shape of the potential nuclear threat by drawing on chemical analysis to provide a nuclear "fingerprint" of the device that produced it.

Another category of Cold War nuclear intelligence was not created in a critical mass explosion, like fallout; rather, it depended on the capture and analysis of isotopes created in the transmutation of uranium into plutonium to provide a direct insight into how much fissile material the Russians produced. For a number of technical reasons, centering on the fact that it can be chemically separated from the substrate of other elements found in fuel rods containing it, it is considerably less costly to produce plutonium-239 for use as fissile material in weapons. While uranium-235 is also used as fissile material, the fact that it is chemically identical, if isotopically distinct, from the natural uranium it forms a tiny percentage of in its natural state makes it far more difficult to separate. While weapons utilizing Pu-239 are necessarily more complex, the extra cost of design complexity is offset by the difficulties of obtaining sufficient U-235 as a fissile material required to make the relatively cruder and heavier uranium weapon designs feasible.[1220] There was some experimentation with other such indicative isotopes, but by

[1219] Identification of the source of fissile material is a key part of the current "war on terrorism" and its approach to the potential use of nuclear weapons by terrorists. The quickest means to determining the source of a detonated device is by identifying the source of its fissile material in samples drawn from the attacked location and its surrounding environment. Even crude, improvised nuclear devices, including some of those of sub-critical/"dirty" design, would most likely incorporate diverted fissile material from known sources, as obtaining an improvised weapon's fuel is the most expensive, technically arduous, and physically massive part of the supply chain for potential non-state actors.

[1220] This is a general discussion. Uranium in some form, as either fissile material or as a tamper to help contain and focus the initial nuclear reaction for greater efficiency, is present in many nuclear weapons. It should also be noted about the simplicity of uranium bombs that the first nuclear weapon used in war was the untested "Little Boy"

1950 AFOAT-1 and the British settled on krypton-85 as the benchmark for monitoring Soviet plutonium production. Accuracy of this technique's estimates to be within 5% of actual Soviet fissile material production was quickly reached.[1221] This was also one process where stationary sampling proved as accurate as airborne capture. Krypton-85 apparently mixed fairly evenly in the atmosphere, due to its 9.4 year half-life, unlike the heterogeneous mixture of bomb debris found in fallout plumes. The relatively long half-life of krypton-85 and the additive nature of the resulting numbers provided a smoothing effect to the data that lent itself well to achieving accuracy within 5%. The method involved calculating total British and U.S. production of krypton-85 based on their own production of it in the course of obtaining fissile material for the West, then subtracting the Western total from the total volume. The remainder would represent the total volume of Soviet production, as the Russians were the only other known producers of fissile material in the early 1950s.

Basics of Analytic Radiochemistry

In the available, unclassified literature, there are scattered references which suggest the identity of the isotopes of interest for intelligence uses, but it is believed there is no single source which states explicitly the information summarized in this appendix.

The first requirement for an isotope useful in detecting a nuclear explosion is an appropriate half-life. The half-life of an isotope is the length of time taken for one-half of the atoms of a quantity of a particular isotope to decay into its daughter isotope. Radioactive decay is a random process for any individual atom, with the half-life being essentially an average of the decay times for all atoms in a sample of an isotope. Thus, the time for any individual atom to decay can be either shorter or longer than what is known as the half-life of that isotope.

During a nuclear explosion, many short-lived isotopes are produced, some lasting as little as a fraction of a second before they decay. Many of these are of interest in analyzing the design and efficiency of bomb design. This information was collected by samplers flying directly into nuclear clouds shortly after an explosion. Even for very short-lived isotopes, enough remaining atoms could still be captured within the sample to allow for accurate analysis. The need for speed

---

device, apparently considered so reliable that the extra U-235 required to test it was reserved for use in case of continued war need.

[1221] Memorandum by R. C. Maude and D.L. Northrup, AFOAT/1, for Mr. Robert LeBaron, Deputy to the Secretary of Defense for Atomic Energy, "Notes on Technical Cooperation with British and Canadians in the Field of Atomic Energy Intelligence," 21 March 1951, U.S. Advisory Committee on Human Radiation Experiments, http://nsarchive.gwu.edu/NSAEBB/NSAEBB7/docs/doc01.pdf.

and accuracy in collecting these samples and returning them to the laboratory for analysis was one reason the Air Force chose to rely on manned aircraft for this mission over the primitive, cumbersome drones available during the period of U.S. atmospheric testing.

For long range detection, what was desired as a marker useful for intelligence purposes was an isotope that persists for a period long enough to be detectable at great distances, yet is also one that decays quickly enough to give an accurate measure of the time span since the explosion which produced it. The location of the original Soviet testing grounds on the steppes of Kazakhstan near Semipalatinsk resulted in samples taking five days or more to drift on the prevailing winds before they became accessible to Air Weather Service aircraft on sampling tracks over the western Pacific north of Japan.[1222] Later, the USSR established testing grounds on the Artic island of Novaya Zemlya. The access provided by international waters around it also provided quicker access to Russian bomb debris by U.S. long-range sampling aircraft.

It is also important that isotopes of interest be produced in large enough quantities in a nuclear explosion to be detectable at long distances and that they are distinguishable from isotopes produced by other nuclear processes, such as natural decay and plutonium production. The major way in which samples from nuclear explosions and reactor operations are differentiated is by assessing the "birthday" of each isotope in a sample. Critical mass nuclear explosions produce samples in which all the isotopes have the same birth date. A sample in which the birth dates of the isotopes analyzed differ is produced in a reactor, which operates via a series of controlled chain reactions.[1223]

Tables of isotopes and their commonly recognized half-lives are available from several sources. First, the *CRC Handbook of Chemistry and Physics* provides basic information, including a table of isotopes, giving their atomic mass, half-life, decay mode, and relative natural abundance (for naturally occurring isotopes.)[1224] Second, and ultimately most useful, is the *Trilinear Chart of Nuclear Species*.[1225] Given its early publishing date of July 1949, the edition used here provided insight into the database of commonly recognized isotope information available for use by AFOAT-1 just before the detection of Joe-1. In addition to basic information

[1222] The Nevada Test Site, which went into use by the United States in 1950, provided a test ground for relatively lower yield shots reflected a siting decision similar to that used by the Russians in 1949 for Joe-1 and its other early tests. The Soviet Union did not have a far flung empire of remote sites suitable for testing like the United States did in the South Pacific.
[1223] Zeigler and Jacobson, *Spying without Spies*, 109.
[1224] David R. Lide, ed. *CRC Handbook of Chemistry and Physics (83rd Edition)* (Boca Raton, FL: CRC Press, 2002).
[1225] William H. Sullivan, *Trilinear Chart of Nuclear Species* (New York: John Wiley & Sons, 1949).

as provided by the *CRC Handbook*, the *Trilinear Chart* showed the relationships between parent and daughter isotopes, allowing the researcher to quickly determine if particular isotopes of interest fit the general pattern of utility described above.

A perusal of the literature provided additional clues for the researcher. Ziegler and Jacobson note that there are about a dozen isotopes which produce easily measured beta radiation and are of greatest interest in analysis.[1226] A key piece of information in tracking down the isotopes of interest in nuclear intelligence was provided by William B. Scott, a former AFTAC Special Equipment Operator, who wrote a series of articles on AFTAC and its history which appeared in *Aviation Week and Space Technology*.[1227] He mentioned that "[t]he gas of primary interest is a radioactive xenon isotope…[with] a 12-day maximum half-life, and is an indisputable signature of a nuclear detonation." Comparing this information with isotope references shows that xenon-131m is the isotope which he alluded to in his article as it is the only xenon isotope with an 11.84-day half-life fitting his description. Interestingly, xenon-131m has the same atomic weight as a naturally occurring xenon isotope, xenon-131. The decay of xenon-131m into xenon-131 is by way of an isomeric transition, with an emission of gamma rays, but no emitted particle. The result is a change in the spin of the xenon atom which can be detected by means of gamma ray spectroscopy.[1228]

Importantly, the parent isotope of both xenon-131m and xenon-131 is iodine-131. When iodine-131, with a half-life of 8.02 days, decays, it emits beta particles. Most of the iodine-131 (98.91%) decays into stable xenon-131, but a little over one percent becomes xenon-131m. So far, it is undetermined whether this process produces both isotopes of iodine-131 in a reactor, but it may be that the transformation into xenon-131m is only possible for iodine-131 produced in the high energy flux of a nuclear explosion, since, by definition, an isotope subject to isomeric transition is one that is in an excited state containing excess energy.[1229] This would account for the statement by William B. Scott that samples containing xenon-131m are uniquely identifiable as produced in a nuclear explosion.

[1226] Zeigler and Jacobson, *Spying without Spies*, 110. Alpha particle detection and measurement was initially limited by a relative lack of alpha-sensitive radiometric equipment.

[1227] William B. Scott, "Debris Collection Reverts to Ground Sites," *Aviation Week and Space Technology* (V. 147, No. 18, 3 November 1997), 59.

[1228] Gamma ray detection was proven technology increasingly easy to measure as electronics were applied to process the signals from Geiger-Müller tubes.

[1229] U.S. Environmental Protection Agency. "Other Modes of Radioactive Decay." http://www.epa.gov/radiation/understand/positron.htm .

By measuring the ratio of the parent iodine-131 to the daughter xenon-131m in a sample, the combined half-lives of the two isotopes provide a window of about 20 days in which the ratio between the parent and daughter isotopes in a sample changes constantly. This allows the age of a sample to be accurately determined. The identification of this specific decay chain used in nuclear intelligence is important, because it demonstrated that AFOAT-1 was closely monitoring iodine-131 continuously during atmospheric testing. The AEC did not identify this isotope as problematic due to its propensity to bioaccumulate in the thyroid gland, where its decay emits both beta and gamma radiation, until after the Windscale accident in 1957.[1230] While the historical data AFTAC holds about iodine in fallout remains classified, access to it is important to assist the Centers for Disease Control in going forward with studies to determine the health impact of atmospheric testing on humans.[1231]

One of the most comprehensive sources of information on the radiochemistry of isotopes is the National Academy of Sciences *Nuclear Science Series: Monographs on Radiochemistry and Radiochemical Techniques, Elements*. These volumes are available on the internet for most isotopes, but the one for xenon is missing from the collection.[1232]

The history of isotopes relevant to nuclear intelligence remains to be explored in detail, a potential project of great interest for students with the suitable chemistry background. For instance, it is known that the efficiency of a particular nuclear weapon design can also be determined by debris analysis. Suggestive of which isotopes might be useful for this purpose is a reference by Richard L. Miller to strontium-90. This isotope was the first one considered problematic enough to be extensively studied by the AEC because it has a relatively long half-life of 28.79 years and its propensity to being taken up by the body in place of calcium and deposited in bone. Strontium-90 emits beta particles as it decays into yttrium-90, another

[1230] Several of the oral history discussions on the1949 GREEN RUN experiment at Hanford noted the AEC maintained sheep there to study the effects of iodine-131 deposition on fodder, given the facility was involved in ongoing releases of the isotope as part of the plutonium-239 production process. Hacker, 123-124, noted the sheep studies only began in 1950. Regardless, little was done with this data prior to the 1957 Windscale incident shifted public attention to iodine-131, largely because of the relationship with nuclear intelligence operations.

[1231] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and the National Cancer Institute, *A Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations* (Washington, DC: U.S. GPO, 2001), 14. http://www.cdc.gov/nceh/radiation/fallout/default.htm.

[1232] National Academy of Sciences, National Research Council, "Nuclear Science Series: Monographs on Radiochemistry and Radiochemical Techniques, Elements." It remains to be determined whether it is otherwise available or if it has not been released due to its still being classified http://lib-www.lanl.gov/radiochemistry/elements.htm. UPDATE: Xenon's monograph remains missing from the Los Alamos National Laboratory page, which has been updated to 2015.

radioactive isotope. Although Miller does not cite a source for his information, he remarks that "[f]or every 1,000 uranium atoms undergoing fission in an atomic device, there will be…about fifteen atoms of the radioactive gas krypton-90" formed. This is part of a decay chain which creates strontium -90 within a minute of a nuclear explosion.[1233] The ratio of uranium to krypton could be evaluated along with other data to determine the efficiency of a weapon design in its use of fissionable material. Thus, strontium-90, of interest to the AEC for health reasons and for evaluating its designs of U.S. weapons, may, like iodine-131, be of interest to AFTAC for the insight it may give into foreign weapon design efficiency.

For fusion weapons, the information is limited on what isotopes may be of intelligence interest. The only specific reference I have found so far is to the use of beryllium-7. This isotope, with a half-life of about 53 days, is formed by the fusion of lithium-6 and lithium-7 with deuterons in a thermonuclear reaction. Measurements of beryllium-7 were reported to have been used by Soviet bomb designers as a way to gauge the efficiency of the thermonuclear reaction.[1234] Since the application of this method is so far unclear in its application to the author, I have omitted it from the table below.

Summary of Isotopes

The following is a summary of decay chains of primary intelligence interest, based on the half-lives of the isotopes involved. Approximate half-lives are listed underneath each isotope, along with the total of half-lives in each chain.

tellurium-131 → **iodine-131** → **xenon-131m** → xenon-131
(25 minutes) → (8 days) → (12 days) → stable = 20 days, 25 minutes
or alternatively
tellurium-131m → **iodine-131** → **xenon-131m** → xenon-131
(30 hours) → (8 days) → (12 days) → stable = 21 days, 6 hours

bromine-86→ **krypton-90**→ rubidium-90 → **strontium-90** → yttrium-90 → zirconium-90
(4.5 sec.) → (33 sec.) → (158 sec.) → (25 years) → (62 hours) → stable = ~25yrs+
bromine-85 → **krypton-85** → rubidium-85
(3 minutes) → (9.4 years) → stable = ~9.4+ years

[1233] Miller, *Under the Cloud*, 202-4.
[1234] David Holloway, *Stalin and the Bomb* (New Haven, CT: Yale University Press, 1994), 304.

Appendix B: Estimated Pu-239 Production, Stockpiles, and Warheads, 1945-1965

Fallout and the very public political and strategic crises it fostered are the focus of this narrative, as it was vital to proving Soviet acquisition of first fission weapons, the original objective of the Air Force's nuclear intelligence program, and then fusion weapons technology. While its importance in positively confirming the source of signals suggesting a nuclear detonation had taken place continued, it is arguable that a closely related krypton-85 atmospheric sampling program to detect and document Soviet fissile material production was even more important to justifying the growth of the Cold War U.S. Air Force.

As discussed in Appendix A, a radioactive but inert noble gas isotope, krypton-85, is a by-product of the irradiation of uranium to produce plutonium-239, the essential fissile material that forms the core of most nuclear weapons, both fission and fusion. Given off in direct proportion to the amount of plutonium-239 produced in the transmutation of uranium, it built up in the atmosphere in limited, but detectable amounts. Initially, all such reactors were devoted to weapons production, so the assumption that the quantity of krypton-85 was directly related to military fissile material stockpiles was a valid one. As discussed in the text in relation to GREEN RUN, the United States began filtering reactor effluent gases in the late 1940s at Hanford, but this seems to have been an incomplete effort. Complete filtering was not necessary, as the Soviets obviously knew from press reports and test announcements the United States was producing large quantities of plutonium.

The first Soviet civilian power reactor went online in 1954, but given the international situation at the time was likely considered by the Air Force to contribute to the Soviet stockpile in practice; there was nothing to prevent its fuel rods from being processed and the plutonium recovered for military use.[1235] American plants presumably represented no issues in obtaining the relevant information to make adjustments to estimates of the atmospheric load of krypton-85 due to their production of it after the first U.S. civilian reactor went on line on 2 December 1957.[1236] Dwight Eisenhower's proposal for an International Atomic Energy Agency came prior to the Soviet civilian plant's initial operation, but one of its goals was to document civilian applications of nuclear energy, a goal certainly compatible and likely not coincidental with AFOAT-1's sub-

[1235] "The World's First Nuclear Power Plant,"7 July 2009, http://englishrussia.com/2009/07/07/the-worlds-first-nuclear-power-plant/.

[1236] Willis L. Shirk, Jr., "Atoms for Peace in Pennsylvania," *Pennsylvania Heritage*, Vol. 35, No. 2 (Spring 2009), http://www.portal.state.pa.us/portal/server.pt/community/history/4569/it_happened_here/471309.

rosa goal of measuring plutonium production via krypton-85 monitoring. Continuing U.S. support for the IAEA in its early years thus may have been predicated in part on the usefulness of the access it provided in documenting plutonium-239 produced in civilian nuclear plants. In order to adjust AFOAT-1/AFTAC's calculations or at least contextualize the gross quantity of krypton-85 present in the atmosphere at the time due to ostensibly non-military production once the krypton-85 from Western production was discounted from the total atmospheric load of this rare noble gas isotope. Obviously, as civilian reactor operations increased, it complicated what began as a relatively straightforward process. The United Kingdom also played a role, coordinating with the United States on the covert effort to estimate Soviet plutonium-239 production, while sharing information on its own production. The rapid increase in civilian power reactor operations in the late 1950s was likely another reason the British dropped their active support for what had been the bilateral MUSIC krypton-85 monitoring program.[1237]

Despite years of denials, Canada shared to a limited extent in producing plutonium that went into American weapons, thus likely shared enough access to account for the plutonium it produced, a legacy of its participation in the Manhattan Project.[1238] In France, civilian nuclear power came before military, but the nation's weapon's program quickly ramped up into the first major non-Soviet bloc target for AFTAC by the time of its first test in 1960.[1239] The first Israeli reactor was an American one in 1960, but the French built another for Israel that began operating in 1962 and certainly raised concerns about the size of the "unofficial" Israeli stockpile in its nascent form. From there the problem of using krypton-85 to monitor Soviet weapons production became increasingly complex as many nations joined in building nuclear plants, often as much for the prestige as for the power. It was likely AFTAC's use of the method continued even after its limitations were encountered, as this provided a baseline for comparison in case large, unexpected increases were detected.

[1237] The primary conclusion about the British exit, beyond the stated financial burden, was the British likely considered they learned all that was needed about the size and composition of the Soviet arsenal once it established that the USSR possessed sufficient fissile material to build hundreds of weapons. Once the additional problem of fallout from both East and West was accounted for, the strategic considerations for the British were virtually the same whether the Russians had 500 weapons or 5,000.

[1238] "Canadian Plutonium Sold for American Bombs," Canadian Coalition for Nuclear Responsibility, http://www.ccnr.org/DOE.html.

[1239] The People's Republic of China was already targeted, but the Air Force, like much of the rest of the intelligence community, mistakenly considered the Chinese nuclear program as primarily an extension of Soviet efforts.

While the analyses and estimates AFOAT-1 derived from its krypton-85 sampling remain classified, a number of estimates of fissile material production emerged after the end of the Cold War opened many other records. These form a fairly reliable and congruent record of what was available for AFOAT-1 to detect.[1240] Combined with a fundamental accuracy of the technique, the general agreement of these estimates form a "virtual report" on the information made available to Cold War policy- and decision-makers by means of the AEDS as operated by AFOAT-1/AFTAC.

For this project, the data provides an ongoing contextualization of other events as actors within the national security establishment pursued what they believed were the best available outcomes under the circumstances. In data-driven organizations such as the Air Force, as well as in politically-oriented ones like the White House, important metrics are closely and regularly observed, up to and including the president, whose signature, initials or presence at a meeting was noted on multiple documents of a similar nature. Thus, making them available to historians to use provides important context in evaluating the history and outcomes of policy decisions. The goal in creating this sort of reference is to identify trends over time, not to account for every pound of plutonium. The governments involved cannot account for their stockpiles that precisely, so any expectation that the available estimates, including these, should be able to do so represents a persistence of nuclear absolutism that is not particularly helpful. Obviously, if at some future point the actual intelligence reports generated from what was detected became available, an analysis would provide additional insight into their accuracy in relation to documented production.

[1240] Being estimates, there are variations in the sources on annual and cumulative totals. While details vary, all are in general agreement on historic trends in Cold War fissile material production. For this project, the database generated by the International Panel of Fissile Materials was the primary source. The IPFM is an independent organization that draws on support from Princeton University's Program on Science and Global Security and the John D. and Catherine T. MacArthur Foundation of Chicago. http://fissilematerials.org/ipfm/.

Table 1: US/USSR Annual and Cumulative Pu-239 Production

Year	US Pu-239 annual kg	USSR Pu-239 Annual kg	US BEU Annual	USSR BEU Annual	US cumulative kg	USSR cumulative kg	US BEU Cum.	USSR BEU Cum.
1947	0	0	11*	0	0	0	11	0
1948	400	17	64	2	40	17	75	2
1949	150	19	15	3	550	36	90	5
1950	250	40	40	6	800	76	130	12
1951	350	140	56	22	1150	216	186	34
1952	250	240	40	38	1400	456	226	73
1953	700	350	112	56	2100	806	338	130
1954	850	325	137	52	2950	1131	475	182
1955	1100	350	177	56	4050	1481	652	238
1956	2000	600	322	96	6050	2081	974	335
1957	3200	750	516	120	9250	2831	1490	456
1958	3900	850	629	137	13150	3681	2119	593
1959	4000	1250	645	201	17150	4931	2764	795
1960	5000	1250	806	201	22150	6181	3570	996
1961	6000	1700	967	274	28150	7881	4537	1271
1962	5700	2100	919	338	33850	9981	5456	1609
1963	6000	1900	967	306	39850	11881	6423	1916
1964	6400	3000	1032	483	46250	14881	7455	2400
1965	6600	3500	1064	564	52850	18381	8519	2964
			* indicates Manhattan Project legacy stockpile					

All data subject to rounding

USSR data: International Panel on Fissile Materials. "Global Fissile Materials Report 2010, Balancing the Books: Production and Stocks," http://fissilematerials.org/library/gfmr10.pdf (GFMR 2010), 49.

US data derived from: GFMR 2010, http://fissilematerials.org/library/2010/12/global_fissile_material_report_4.html, 35;

US production revised to reflect US DOE, *Plutonium: The First 50 Years*, http://fissilematerials.org/library/doe96.pdf.

BEU = 6.2 kgs, the approximate minimum rough critical mass for Pu-239 device, http://blog.nuclearsecrecy.com/2015/04/10/critical-mass/

Another source defines this approximate value as 4 kg: http://fissilematerials.org/library/2010/12/global_fissile_material_report_4.html, 29 n. 113.

Note: For USSR, annual Pu-239 production averaged 4.5 metric tons/year from 1965-1990. GFMR 2010, 49.

Note: For UK, total Pu-239 weapons grade production, 1951-1990, was only approximately 4 tons, so not charted with above. GFMR 2010, 80.

Note: This data omits uranium-235 stockpile data, which the GFMR 2010 includes. U-235 was not directly monitorable, unlike Pu-239, making it difficult to directly address knowledge of it during the Cold War.

Appendix C: Nuclear Intelligence Sources

Any discussion of primary and secondary sources on the topic of fallout in the context of nuclear intelligence, as well as the historical legacy of the AEDS and its impact on Cold War policy and strategy must start by pointing out the difficulties of sufficient access to the documentary record to gain some narrative and argumentative traction. Yet, pioneering efforts made some two decades ago have finally resulted in a critical mass of historiographic work that in some sense rewards the personal research and writing struggle over the course of most of that time to discover, understand, and organize what was available on this difficult topic.

First, a few words about the focus on empirical research here, as attention to the effects of fallout as recorded in the evidence presented is a major technique used to fill in still numerous gaps in the historical record.[1241] This does not exclude subjective experience and narrative so much as it suggests the need for a broad and inclusive agenda of evidence. The argument here suggests that the predominance of models of subjective reactions to fallout was largely the result of an intentional effort by the Air Force to limit the availability of quantifiable data to examine, analyze and draw conclusions from for researchers. A concerted effort was made to conceal these fact sets for reasons that were mostly reasonable at the time (but which a half century or more later are less and less so); it is clear that the government was influenced by the secrets it held and denied to others in repeatedly changing its policy toward fallout. Ultimately, it chose the option of not creating more facts by suspending atmospheric testing entirely, suggesting it was not only public opposition and mere scientific interest in fallout that caused it to concede. Since so much of this highly relevant data remains classified, linking the familiar subjectivities of fallout to a coherent outline of what is known about the role fallout and other nuclear intelligence played in shaping Cold War policy is an important link in assessing the past, as well as dealing with a future that for now faces far too many nuclear weapons.

Early in this project, given the sensitivity of the topic and the limited declassification of relevant primary documents, adherence to a subjective approach appeared the more productive path to follow. The volume of data remaining classified was daunting. However, it became clear that the policy decision to end fallout, while influenced by the subjectivities of public pressure, was primarily based on quantifiable data about accelerated deposition of fallout from testing

[1241] After Ellysa Stern Cahoy's definition of empirical research: "Empirical research is based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief." https://www.libraries.psu.edu/psul/researchguides/edupsych/empirical.html.

back to the surface. No sustained attempt is made to analyze the relative merits of different theories of risk associated with radiation exposure or to evaluate the standards established in reference to those theories. However, given this is a historical narrative, the subjectivities of reactions to facts and data remain of interest and must not to be excluded. What was key here was that these numbers caused policy makers to act. While there may be different points of view on their meaning, there was ultimately a single set of facts, even if these may lead to differing conclusions about the meaning and significance of fallout. The absence of facts can also be telling, as Eisenhower and others worried when the United States halted atmospheric testing in late 1958, foregrounding the absence of fallout, but also calling attention to its threat.

The seminal work here was 1995's artfully accomplished *Spying without Spies: Origins of America's Secret Nuclear Surveillance System* by Charles A. Ziegler and David Jacobson. Accomplishing exactly what its title describes, the authors left a note in the preface pointing toward their identification of Doyle Northrup's official internal "History of Long Range Detection, 1947-1953" as a key document for those who followed them.[1242] Unfortunately, despite the efforts of this project in prying loose AFOAT-1 and AFTAC official annual unit histories and a number of other documents in reasonably useful and complete form, it remains a document too sensitive in the eyes of the Air Force to disclose.

For now, the limited comments in the now-extant unit histories and the secondary literature will have to stand in for Northrup's frank views on the matter.[1243] But an interesting light was thrown on Northrup's still secret early operational history by declassification of the unit histories. The first unit history covers the years from 1947 to 1953 and is, coincidentally enough, entitled "History of Long Detection, 1947 -1953." But there is no visible mention of Doyle Northrup, although the reproduction of the cover page is so poor and smudged that it is conceivably possible it was on the document, yet not visible.[1244] A comment in the front matter

---

[1242] Charles A. Ziegler and David Jacobson, *Spying without Spies: Origins of America's Secret Nuclear Surveillance System* (Westport, CT: Praeger, 1995), vii.

[1243] The National Security Archive was the first to succeed at declassification of two year's span of the AFOAT-1 annual unit history, which Michael S. Goodman used to effect in his 2007 examination of the parallel British nuclear intelligence effort. The NSA generously shared these, a debt hopefully repaid with adding to what was now in the public domain in the course of this project. The author's mandatory declassification review (MDR) requests for all other years between 1947 and 1964 were eventually honored, with sizable, but not crippling redactions. Several years' efforts required appeal of initial denials to the Interagency Security Classification Appeals Panel (ISCAP), which largely sided with disclosure suggesting optimism for more progress for future researchers.

[1244] Comparison with the apparently identically formatted 1954 cover sheet indicates Northrup's name was not on the 1953 cover as an author.

from AFOAT-1 Chief, Brigadier General Daniel E. Hooks, makes no mention of Northrup, referring only to the assistance of the Air University Historical Liaison Office. The total of 328 pages instead of the Northrup document's 330 pages also suggests a different document than the one the chief scientist authored. Publication date of the declassified unit history appears to be June 1954, which as noted in the narrative was subsequent to both CASTLE BRAVO in the early spring and the Oppenheimer hearing in the late spring, as it was signed by Hooks with that date appended; the publication date of Northrup's history is uncertain, although a three-hour plus oral history interview from 1973 was discovered that also remains classified despite an entry stating it was unclassified.[1245] Interestingly, the 1955 unit history described Hooks taking command as a colonel from the previous commander, Brigadier General William C. Canterbury, in June 1954, then being promoted to Brigadier General on 9 October 1954. Canterbury's middle initial is even corrected to "M" above the erroneous "C" suggesting the document was subsequent to its publication reviewed and corrected. The evidence strongly suggests that the unit history was published later than June 1954 and then backdated for reasons that are not clear.[1246] What this all means requires further investigation, as it would be interesting to confirm there were at least two secret histories, only one that was recently made available to the public. Patient readers may also wonder what Northrup said about Robert Oppenheimer. Oppenheimer was mentioned by name in relatively neutral terms at several points in the 1947-1953 unit history. At others, there was a more anonymous undercurrent of bitterness over seeming "lost opportunities" much as General Wilson described with such vague effect at Oppenheimer's AEC security hearing. As Chief Technical Officer, Northrup closely interacted with Oppenheimer on a number of occasions, including defending the disputed Air Force requests to augment LRD efforts that went before the Research and Development Board's review committee Oppenheimer chaired. Thus what the direction of the evidence suggests is now even more tantalizing, perhaps even suggesting why the Air Force has resisted release of such a seemingly dated document – and perhaps why there seem to be some chorological issues with the publication date of various histories of AFOAT-1.

Ziegler and Jacobson were instrumental in pointing toward a number of ways at getting to usable evidence, so a thoughtful read of it is basic for any researcher in this area. Most important

---

[1245] A MDR for the oral history interview transcript with Northrup remains pending, with a letter indicating the Air Force was searching for the document. Document Detail for IRISNUM=00904802, www.airforcehistoryindex.org.
[1246] AFOAT-1, 1947-1953 Unit History, iii; AFOAT-1, 1954 Unit History, 4.

for this project was their imparting the understanding how American testing served as a "laboratory with space" enough to research and develop methods of long range detection (LRD).

Jeffrey T. Richelson was next into the fray. More than a decade after *Spying without Spies* opened the neglected sub-field, the dean of American intelligence history weighed in with the ambitious sweep Richelson is known for with his 2006 *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea* (New York: W.W. Norton and Company, 2006.) The focus was on the more general overall view of the problem from the view point of the CIA and the period this work concentrated on was passed by roughly one-third of the way through as Richelson chose events to shape the overall thrust of the volume around topical areas of more recent vintage. The normally somewhat more succinct seemed as overwhelmed as this author by the richness of the subject. Richelson's focus was also more exclusively on the intelligence angle, where the goal here is a broader one of fallout's role in the policy formation process in a much narrow times frame. It is a work extraordinarily useful for the researcher, while retaining the accessibility Richelson remains justly famous for.

Michael S. Goodman rounds out the trio of previous forays into this area by focusing on the efforts of British nuclear intelligence with his 2007 *Spying on the Nuclear Bear: Anglo-American Intelligence and the Soviet Bomb* (Stanford: Stanford University Press). While Goodman does not read as breezily easy as Richelson, he nonetheless does a stellar job of presenting the English effort for its largely independent efforts. While the British would have liked a closer nuclear partnership with the Americans, the various missteps resulting from the Philby and other affairs left the "special relationship" in atomic tatters. The remnants left were the often ethereal ones associated with nuclear intelligence, which seems to inoculate the partners against a more permanent breach even as it served as a focal point for a steady nibbling away at the space between the two.

The field of the published Cold War personal memoir is large and seemingly still growing. While the quality can be highly variable, the record of AFOAT-1/AFTAC in inculcating those assigned to it in security culture seems more than modestly successful and long-lived. To the author's knowledge, any such publications are below the radar and most likely self-published, with very limited distribution. The Kelsey Wynns memoir on sampling IVY MIKE and another confidential one from a source who worked outside of fallout sampling for

AFOAT-1 represent the bulk of writing on this angle used here, along with some scattered communications here and there.

Turning to nuclear testing itself, the literature is extensive, but tends to focus on the Western test series. A similarly useful literature may exist in Russian, which is merely suggestive of the potential for new topical orientations that might be achieved through familiarization with the "three Hs" – Chuck Hansen, Bart Hacker, and Richard Hewlett, et al. These provide the researcher with a solid grounding in the milieu, as well as providing opportunities for the attentive reader to begin to see the role of nuclear intelligence research and development as it played out from multiple angles while concealed within the test organization.[1247] The work of all three was colored by the lack of access in the era of their work to the relevant documentary data, but once one begins to look for real historical "gaps" where the absence of mention of fallout at a point where the reader concludes more must exist than is often depicted in these works. These points become increasingly obvious as one works with the topic.

Depending on the specific starting point, the available evidence, and argument being made, the range of other secondary sources of potential value varies widely. Among these topical areas found most useful were works from the history of science, science and public policy, weapons testing, intelligence and military history, and arms control history. Gleaning a basic reading list from bibliography provides a good start if one chooses carefully.

While a relatively recent development because of declassifications, there are a number of primary document collections whose holdings far exceeded my capacity to examine all in detail. The staffs at both the Dwight D. Eisenhower Library in Abilene, Kansas, and the John F. Kennedy Library in Boston, Massachusetts, were very solicitous and helpful in facilitating the work of a relatively inexperienced researcher. In particular, David G. Haight's "Nuclear Testing: A Guide to Historical Holdings in the Dwight D. Eisenhower Library" was invaluable in making the most of limited research time and is highly recommended.[1248] My files now bulge with the harvest of valuable and insightful documents. As with many archives, these National Archive and Records Administration (NARA) facilities permit use of digital cameras; with good planning and discipline, plus lots of batteries, it is possible to walk away with literally thousands of document images with a week's work. The primary NARA facility in College Park, Maryland is

[1247] See Bibliography for complete list of works used herein.
[1248] Haigh's guide is available by emailing the Eisenhower Library at the address in the following link: http://www.archives.gov/publications/presidential-materials.html.

notable for its absolutely essential, but rather limited AFOAT-1/1009th SWS and Project Sunshine collections. NARA also holds the declassified CIA holdings there if one has the time and inclination, as this was an area where limited time and resources limited my own use of such documents.

While not a government agency, the National Security Archive takes on policy and secrecy in the interest of creating a more complete and transparent historical record of government action. William Burr and others there were helpful and responsive. Much is available online, but researchers should inquire in case they are able to locate other documents in their vast holdings of declassified materials.

The American Institute of Physics' Niels Bohr Library has extensive holdings of oral history transcripts of physicists involved in nuclear intelligence research and development and arms control verification technologies like seismology. They were gracious and very helpful, as well as providing a view of the surprisingly active inside the Beltway wildlife outside on their campus.[1249]

Experience in seeking documents from the Air Force varied from "sorry, no" in an initial foray and inquiry to the military records collection specialists at NARA College Park to very helpful. Mostly, it was somewhere in between, which has proven to be productive and certainly worth the time invested on both sides in the struggle to free a vital part of the Air Force's history from the oblivion of the obscurity from which it was made. AFTAC itself remains singularly silent in most respects, although a nice, printed copy of *A Fifty Year Commemorative History of Long Range Detection* was forwarded gratis once they understood I was a serious researcher. Researchers will continue to knock on that door in the future, but the opportunities elsewhere in the Air Force will likely continue to be more fruitful. There is a historical unit at the Pentagon associated with Air Force headquarters that deals with issues like MDR requests and appeals, as well as distributing copies of declassified records. The Air Force Historical Research Agency is located at Maxwell AFB in Montgomery, Alabama handles historical documents available for researchers. Access to the facility on an active military base was essentially closed after 9/11, but the current status may be different. AFHRA was able to provide a mass of microfilm at reasonable cost. Two primary topics of interest to researchers are available. The records of the

[1249] One rarely expects to see a fox while copying archive materials, especially so in an urban setting, but the AIP's beautiful campus is situated in a park-like setting in College Park, Maryland that encourages contemplation of the natural world, along with science and history.

4080th SRW and its U-2 operations provided considerable insight into one of the more significant "contractors" for AFOAT-1/AFTAC sampling operations, as well as further insight into the intelligence asset that replaced the AEDS as the most important strategic intelligence system. Nearly untouched in the microfilm is a far larger collection of Air Weather Service unit histories and other documents, along with insights into these units' close relationship to nuclear sampling.

It is hoped the focus of this science- and policy-oriented project will serve as a jumping off point for other projects by this author or others. Most obviously the "gap" needing filled is for a military history of AFTAC now that the basic pieces are declassified, including its early unit histories. Other potential projects include a revision of arms control history; a reexamination of the history of science and personal conflict through a fuller recasting of the Oppenheimer affair; polishing a lengthy article expanding on Roger Cross's analysis of Hedley Marston's cheeky "protest by science" of British testing in Australia; and a history of radiometric instrumentation proliferation in the lab, field, and fallout shelter.

An aspirational goal of this project was to create a new holistic framework for Cold War history that forces reconciliation, if not agreement, between often competing and obviously historically incompatible narratives. Efforts were made here to take evidence and analyze from multiple perspectives in order that everyone with a dog in the fight had a chance to speak. In the end, regardless of the invaluable assistance of archivists, other scholars, and even friends over beer, the author takes full responsibility for the views and occasional opinions expressed herein.

Appendix D: Annual and Cumulative Test Yields

Annual test yields varied greatly during the era of atmospheric testing, with the cumulative yield jumping sharply toward the end just before the Limited Test Ban Treaty ended the bulk of such testing in 1963.[1250]

Table 2: Total atmospheric test yields[1251]

	Fission	Cumulative Fission	Fission+Fusion [% of total '45 - '62]	Cumulative Total Fission+Fusion
1945 to 1956 =	51.8 Mt (27%)	51.8 Mt	88.8 Mt (17%)	88.8 Mt
1957 to 1958 =	40.0 Mt (21%)	91.8 Mt	85 Mt (17%)	173.8 Mt
1959 to 1960 =	temporary test moratorium, "No foreign nuclear explosions were detected in 1959."[1252] Only the first French tests were detected by AFTAC in 1960.[1253]			
1961 to 1962 =	101 Mt (52%)	192.8 Mt	337 Mt (66%)	510.8 Mt

The Federal Radiation Council (FRC) made several distinctions in its more complex table that better illustrate how the AEC and the Russians clearly were acting to address the need to limit fallout. By shifting the data into the yearly breakdown used here, it makes clear how important the shift in priority to avoiding fireball contact with the surface was in order to limit fallout. Between 1945 and 1956, 86% of all yield was detonated in proximity to the earth.[1254] The 1957 to 1958 test series saw a drastic change, with only 33% reported fired in surface contact. For total yield, the final cumulative numbers showed that 80% had been detonated in the air, with only about 20% in contact with the surface. The FRC was a bit optimistic in listing no surface contact yield in 1961 and 1962; the Davy Crockett tests that were among the last U.S. atmospheric tests were excluded, but relatively very dirty considering their limited yield (well

[1250] The French began testing in the atmosphere in 1960 and the Peoples Republic of China in 1964.

[1251] Data derived from Federal Radiation Council, *Estimates and Revaluation of Fallout in the United States from Nuclear Weapons Testing* (Washington, DC: U.S.G.P.O., May 1963), http://www.epa.gov/radiation/docs/federal/frc_rpt4.pdf, 5. More recent reconciliations of total yields produced by atmospheric testing are available, benefiting from the end of the Cold War. Here I thought it useful to look at contemporary sources that U.S. Senators who voted on the LTBT might have encountered. Some low yield shots were excluded from these totals as they made little difference once rounding was taken into account. For an insightful discussion of test yield estimates and fallout and fallout, see : United Nations. Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation: Sources* (New York: United Nations Publications, 2000), 158-177.

[1252] AFTAC, 1959 Unit History, v.

[1253] AFTAC, 1960 Unit History, vi.

[1254] The distinction was between "air" and "surface" so fireball contact seemed to be the appropriate metric applied.

under 1 kiloton), with two being fired within a few feet of the surface.[1255] However, this shift to limit fallout as testing proceeded clearly delineated a border between the dirtiest era of testing and one that seemed more clean at the time.

However, "clean weapon" was a very subjective term. The U.S. military defined it as a weapon design producing no more than 5% of the fallout of a standard design weapon.[1256] With thermonuclear weapons, this could nonetheless be a staggering amount of radiation, which the yield totals for later years suggest. The period from 1945 to 1956 produced about 17% of total fallout. Then 1957 and 1958 test yield totals roughly equaled the previous period of 17%. Following the temporary test moratorium, a profligate fit of testing followed in 1961 and 1962, thankfully carried out with no more than very limited fireball contact with the ground underneath, but still totaling some 66% of all atmospheric test yields. While the public made little distinction about fallout's origins, simply wanting it to stop, the FRC took pains to note the U.S. generated a total of only 37 megatons of yield in 1962 (there were no U.S. atmospheric tests in 1961), while the USSR produced some 120 tons of total atmospheric yield in 1961 and roughly 180 megatons in 1962.[1257]

In a sense, the Russians were pulling their punches during their massive 1961-1962 series. The Tsar Bomb (56 megatons, 30 October 1961) was said to be a 100 megaton design purposefully reduced to about half its intended yield. Along with other multi-megaton shots in this series, the Russians seem to have taken pains to go for maximum yield even as they limited potential fallout production by following the American example of avoiding fireball-to-ground contact. The big numbers sent a message, albeit a somewhat muddled one about the dangers of fallout, but the Soviet Union made efforts to limit the fallout danger at least in comparison to lower efficiencies in its earlier test series. The jump in fallout exposures provided a final baseline for whatever was left of GABRIEL to consider. Thus the breakdown into four distinct periods, three passages of testing, increasingly intense, and the "coasting" period from late 1959 to 1961 when new additions of fallout ceased during the temporary test moratorium. In between test series once the distinct plumes from individual shots dispersed samples taken from the upper air were most likely to yield a distinct pattern of generally increasing background radiation through

[1255] The FRC did not include data on devices with a limited yield and thus unlikely to make a contribution to stratospheric fallout.
[1256] "The Clean Weapons Problem," *Air Force Magazine*, Vol. 42, No. 12 (December 1959), 37.
[1257] FRC, *Estimates and Revaluation of Fallout*, 5, Table II.

1958. A plateau of sorts, then the beginning of a general fall in stratospheric fallout levels was likely what the 4080th SRW U-2 samplers encountered in the stratosphere on CROWFLIGHT and other missions during the first temporary test moratorium from late 1958 to 1961. It was a lack of documented persistence that likely contributed to the overthrow of Libby's optimistic elaborations adopted from the Harwell stratospheric residence time theories. While speculative, the March 1959 decision to end atmospheric testing by Eisenhower and his advisers may have reflected the much faster pace of deposition that General Loper argued exceeded Libby's previous sharply shortening revision of his residence time estimates.[1258] If evidence of such accelerated deposition emerged within three months, this data likely provided further strong impetus for Eisenhower's actions following his conclusion that "nuclear testing is bad."[1259]

[1258] Letter from General Herbert B. Loper to Senator Clifford B. Anderson, 19 February 1959, reproduced in Special Subcommittee on Radiation, Joint Committee on Atomic Energy, "Fallout from Nuclear Weapons Tests, Volume 3" (Washington, DC: USGPO, 1959), 2537-2538; Helen C. Allison, "News Roundup: Radiation Problems," *Bulletin of the Atomic Scientists*, Vol. 15, No. 5 (May 1959), 223.
[1259] James R. Killian, Jr., Memorandum for the President, "Technical Factors Relating to Arms Limitation and to the Geneva Conference on Nuclear Test Cessation," Eisenhower Library, Ann Whitman File, Administration, Box 23, 31 March 1959, 3.

Table 3: US/USSR/UK Annual and Cumulative Test Yields, 1945-1965

Year	U.S. annual yield total	U.S. cumulative	USSR annual yield	USSR cumulative	UK annual yield	UK cumulative	Total annual test yield	Cumulative test yield
1945	56	56	0	0	0		56	56
1946	46	102	0	0	0		46	102
1947	0	102	0	0	0		0	102
1948	104	206	0	0	0		104	206
1949	0	206	22	22	0		22	228
1950	0	206	0	22	0		0	228
1951	614	820	80	102	0		694	922
1952	10900	11720	0	102	25	25	10925	11847
1953	252	11972	441	543	18	43	711	12558
1954	48200	60172	122	665	0	43	48322	60880
1955	198	60370	1868	2533	0	43	2066	62946
1956	20820	81190	1976	4509	143	186	22939	85885
1957	342	81532	6243	10752	232	418	6817	92702
1958	36227	115759	16252	27004	5501	5919	57980	150682
1959	0	115759	0	27004			0	150682
1960	0	115759	0	27004			0	150682
1961	0	115759	83230	110234			83230	233912
1962	38246	156005	114275	224509			152521	386433
1963								
1964								
1965								

Total Yield from Atmospheric testing by the Big Three original nuclear ~386,433 kilotons or 386.433 megatons

Yields are stated in kilotons; numbers subject to rounding

Source: http://nuclearweaponarchive.org/index.html

U.S. "test" yields for 1945 include yields for Hiroshima and Nagasaki weapons used in war and as the only wartime yields, were categorized as tests here for simplicity's sake.

Appendix E: AFOAT-1/AFTAC Units and Aircraft

This appendix is a compilation of working documents created in the course of fifteen years of research on this project.[1260] It was designed as an aid to memory and organization of this complex narrative. Additions, clarifications, and corrections are welcome.

AFOAT-1/AFTAC Associated Units, Detachments and Other Organizations

These are generally divided into AFOAT-1/AFTAC and its subordinate units and those other affiliated units associated with support of the AFOAT-1/AFTAC mission.

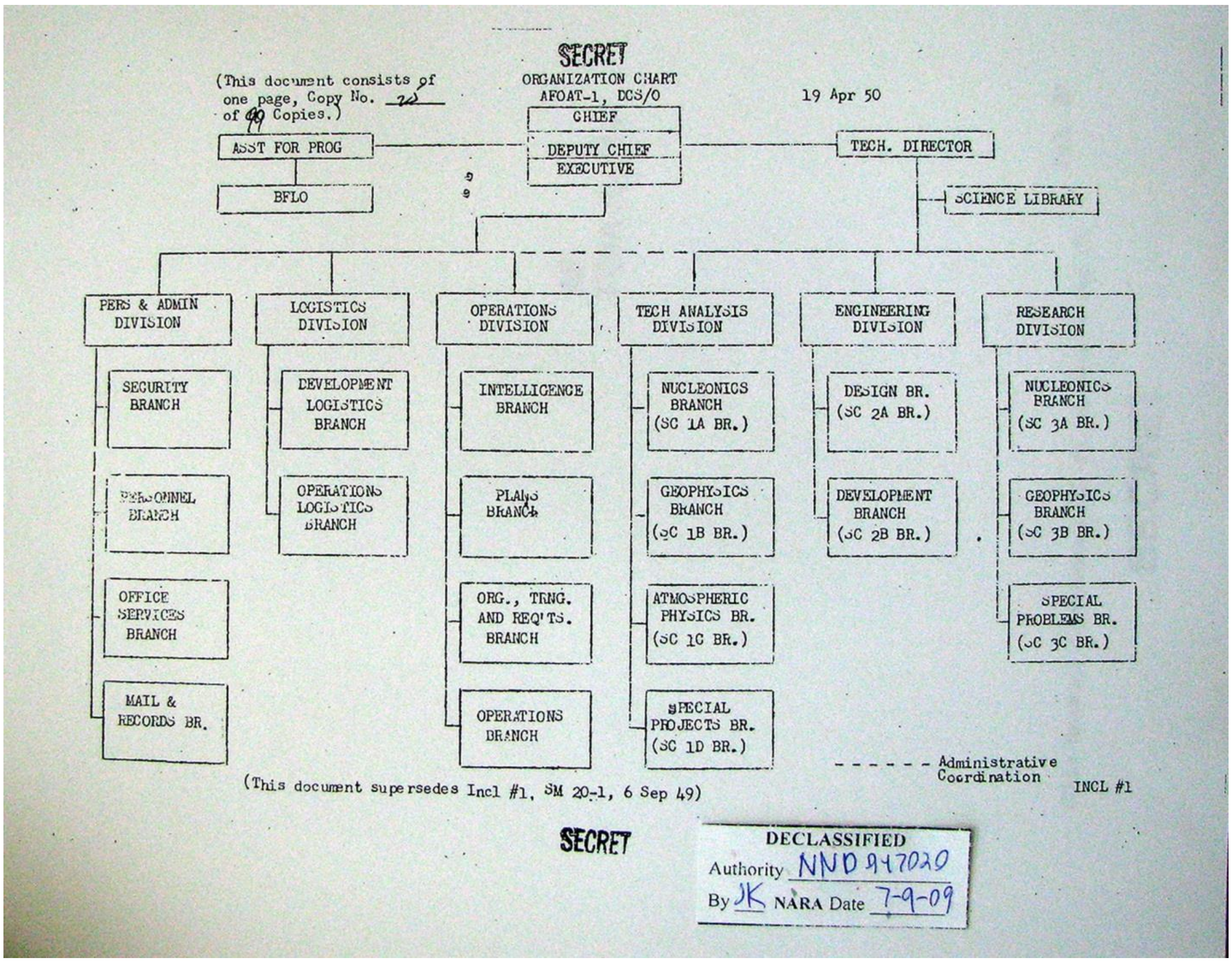

Figure 4: 1950 AFOAT-1 Organization Chart[1261]

[1260] This compilation remains a work in progress; what is presented here is an extract intended to aid other researchers. Additional brief notes are available on request for many but not all of the entries.
[1261] Staff Memorandum 20-1C, "Organization of AFOAT-1," 13 September 1950, Headquarters United States Air Force (Air Staff), NARA RG 341.10.6. Note how the only place for "science" is in the library.

Aircraft Serving the AFOAT-1/AFTAC Mission

General Dwight Eisenhower's assignment of the long range detection (LRD) mission to the Air Force as an antecedent to the service's independence in the formation of the Department of Defense under the National Security Act of 1947 was predicated on the Air Force's unique global aviation capabilities. Over the years operating the AEDS as the mission of first AFOAT-1, then AFTAC, a wide variety of aircraft from a number of other commands served in support of sampling fallout and the atmosphere in support of LRD, along with research and development often associated with the U.S. testing program. A relatively fewer number were used for training and utility tasks.

Generally, sampling aircraft were not assigned to AFOAT-1/AFTAC, but acted under orders as "contractors" for LRD sampling. Crewed by the owning command, they typically carried an enlisted AFOAT-1/AFTAC representative called a special equipment operator (SEO). Besides operating the various sample collection apparatus, filters for particulate debris and compressors and tanks for gaseous samples, the SEO utilized sensitive detectors to vector the aircraft toward fallout plumes. This was one of those rare exceptions to usual military command protocols, with officer/pilots taking direction from enlisted personnel; while technically not commanding the aircraft, the SEO represented the "customer" and following his instructions (all flying personnel during the period of this project were male) was paramount to successful mission completion. A few single-seat aircraft had no seat for a SEO, such as the U-2. In these cases, the pilot was trained to operate the detection and sampling equipment, directed by pre-flight orders that provided the best estimate of where "hot" samples would be encountered.

During the peak fallout years of 1961 to 1963, the total number of aircraft assigned in support of the AEDS peaked at 84 in FY62 and 74 in FY63. In FY62, this included 43 Air Weather Service RB-50; 23 AWS RB-57; 1 AWS RB-47; 8 Strategic Air Command B-52; and 9 SAC U-2. In FY63, the mix was 31 AWS RB-50; 14 AWS RB-57; 4 AWS C-130; 8 SAC B-52; 15 SAC U-2 and 1 each AFTAC C-47 and C-118.[1262]

Thus, AFOAT-1/AFTAC itself "owned" relatively few aircraft and used them primarily for support tasks. Samples needed rapid transport to the appropriate laboratory, to ensure

[1262] AFTAC, *50 Year Commemorative History*, 63. The small shrinkage in the fleet during the intense FY 63 fallout was due to the ongoing retirement of the long in tooth and increasingly dangerous RB-50 samplers in favor of younger airframes and an increased focus on high-altitude collections by the U-2.

documentation through testing that could identify some relevant isotopes before their decay made them undetectable.

The unit flew two versions of the dodgy Lockheed Constellation. The first, obtained in 1957, was one of only two YC-121F Super Constellations the Air Force procured. It was powered by four turbo-prop engines instead of the standard piston engines used on the standard model Constellation, providing impressive performance improvements.[1263] It was equipped to conduct both debris sampling and training for up to four SEOs at a time. The high-performance and specialized nature of the airframe saw it grounded for excessive operational costs by 1959. The airframe was later sold with the other Air Force YC-121F to Flying Tiger, a freight airline, which used the parts to build two running cargo aircraft.[1264] Another Air Force Constellation, a standard piston-engine model with tail number 51-3842, was obtained in July 1959 and converted to roughly the same sampling and training configuration as the first, but with an assigned nomenclature of TC-121C. This aircraft crashed on a test flight out of McClellan Air Force Base, California on 22 March 1961, killing an AFTAC crew of 5 and a Lockheed technical representative who was aboard.[1265] A C-118, the military version of the reliable four piston-engine powered Douglas DC-6, was then obtained and converted to similar configuration as the Constellations.

The deaths in the 1961 crash were only a few of those suffered by those assigned to the LRD mission. More SEOs died on planes flying for the Air Weather Service. During the 1950s, the AWS performed the bulk of sampling operations in support of the LRD program. The AWS benefited by its inclusion in the priority funding status granted to those whose missions supported the AEDS. This hardworking, but frequently crashing collection of WB-29s was expanded by additional conversions from B-29s, resulting in a fleet that peaked at 80 aircraft in 1954.[1266] The AWS weather reconnaissance fleet was expanded to six squadrons by 1951 (and to seven by 1957), continuing to operate along its synoptic tracks, gathering data for weather

---

[1263] This aircraft was either 53-8157 or 53-8158. Extant information on the internet does not identify the specific aircraft involved, its assignment to AFOAT-1, or its connection to LRD operations. See: http://www.network54.com/Forum/213163/thread/1035998833/last-1051127865/Lockheed+R7V-2.

[1264] AFTAC, *50 Year Commemorative History*, 61; http://www.conniesurvivors.com/1-QandA.htm.

[1265] AFTAC, 1959, 1961 Unit History; AFTAC, *50 Year Commemorative History*, 61-62; Accident Report: http://aviation-safety.net/database/record.php?id=19610322-1. It should be noted that it was the TC-121C that crashed in 1961, not the YC-121F that was incorrectly attributed to have been the accident plane in AFTAC's *50 Year Commemorative History* on page 61.

[1266] John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), 236. ©American Meteorological Society. Used with permission.

reports while sampling for signs of radioactive debris. Aircraft flying "specials" began regularly carrying special equipment operators (SEO) assigned from AFOAT-1 who used a crude detection apparatus that was basically a Geiger counter rigged for airborne use. The detector was able to determine if they were within the usually unseen debris cloud, allowing the SEO to direct the pilot to obtain better quality samples than simply flying a surveillance synoptic track would obtain. Following the discovery of debris from Joe-4 on 12 August 1953, which showed that the Russians had again closed the lead the U.S held in nuclear technology by demonstrating its own thermonuclear design, a proposal to cut the number of weather reconnaissance squadrons to four was itself cut short as the Air Force structure expanded from 120 wings to 137 wings. [1267] Replacement of the troublesome WB-29 fleet occurred, leading to use of the equally deadly (to their crews) WB-50, itself basically an improved version of the B-29. The WB-29s, wracked by engine fires and corrosion so severe that they were eventually banned from flying into typhoons, suffered 8 major accidents before their use ended in 1956, taking the lives of 58 crewmen. The replacement WB-50s had 13 major accidents by 1960, resulting in 66 deaths. [1268] Even in relatively peaceful circumstances, the crews of the AWS regularly risked their lives operating this portion of the AEDS.

It is uncertain how many SEOs died in these accidents, but it looks likely that as many as two dozen were involved.[1269] Page 54 of AFTAC's *Commemorative History* lists sixty-four individuals recorded on a memorial plaque at its headquarters, but some are clearly those who otherwise died while serving, civilians, or both (Walter Singlevich for instance). Many of the losses reflected by contributions to this list were likely due to aircraft accidents over the years, most likely dying in ones and twos as the SEOs flying with the AWS.

The only other mass casualty incident potentially believed to include multiple AFOAT-1 personnel involved yet another Constellation. This C-121 was flying on a transport run for the Military Air Transport Service (MATS) with two other Constellations on a flight from Wheelus AFB in Libya to Dhahran, Saudi Arabia when it crashed short of the runway in fog on an

---

[1267] John F. Fuller, *Thor's Legions" Weather Support to the U.S. Air Force and Army, 1937-1987* (Boston: American Meteorological Society, 1990), ., 234. ©American Meteorological Society. Used with permission. Note that at the beginning of the Gulf War in 1990, a news conference was held in Saudi Arabia to announce the official entry of U.S. military forces into the desert kingdom. Ironically, this announcement was at least 40 years late.
[1268] Ibid, 240-2.
[1269] Since the earliest AWS missions did not always carry a SEO and later missions may have carried more than one, two dozen is a viable estimate of the SEO toll from these 23 aircraft losses.

approach made difficult because the local radar was out of service.[1270] Dhahran was the location of AFOAT-1 Detachment 304 on a base that otherwise served primarily as a service stop for the shorter-ranged aircraft of that era.[1271] With the isolation of the base, there was no other timely way to transport assigned personnel to and from it, so it was quite possible that several AFOAT-1-assigned personnel may have been aboard when 54-0165 went down a mile short of the runway. With the relaxation of the most stringent secrecy that allowed veterans to openly celebrate the organization's fiftieth anniversary in 1997, it seems axiomatic that a more complete accounting of the circumstances of those who died during their service with AFOAT-1 or AFTAC would eventually be forthcoming for public release, whether in-flight, in ground accidents, or other incidents.

Moreover, the converted heavy bombers used by the AWS were limited in important ways that left AFOAT-1 with less than worldwide coverage. Due to budgetary and operational constraints, it was only practical to fly synoptic tracks in areas of greatest interest near the Soviet Union. Specials could be flown where needed, but this depended on detection by ground-based seismic, sonic, and, quite possibly, electromagnetic sensor systems.[1272]

Additionally, the weather aircraft converted from heavy bombers were generally limited to altitudes below the stratosphere, when the power of thermonuclear weapons caused much of their debris to be flung above the tropopause. In the stratosphere, fallout was initially believed to linger for far longer periods. This was a mixed blessing, in that it allowed a longer period for radioactivity to decay. It also created the problem of estimating what exactly the atmospheric loading of fallout was and determining accurately what the rate of fallout disposition would be as it gradually moved down into the troposphere. Valuable intelligence could be gathered about larger thermonuclear explosions in the stratosphere just as it was gathered in the troposphere from fission explosions, but it would require a means to reach altitudes above 70,000 feet. Here is where, spawned as a project on the model of the AEDS program, the U-2 played an important, but heretofore little known, role in this narrative. The U-2 provided AFOAT-1 with the capability "to conduct strategic reconnaissance operations [including nuclear intelligence] on a

[1270] Accident Report: http://aviation-safety.net/database/record.php?id=19561230-0.
[1271] The author's father served at Dhahran's Detachment 304 for a year during 1955 and 1956, missing the birth of his first child, but making his way home safely.
[1272] A "special" was a mission flown at the direction of Headquarters, AFOAT-1/AFTA that was specifically vectored to confirm the location of and obtain a sample from an identified debris plume.

global scale," and to eventually engage in test ban treaty verification, no matter what the height of a nuclear explosion.[1273]

When Gen. LeMay was first briefed on the U-2 in April 1954, he walked out of the meeting, grumbling that the project was "wasting his time with a plane that had no guns." The Strategic Air Command initially rejected the U-2, deciding to acquire converted B-57 light bombers for high-altitude reconnaissance, equipping them with cameras, EMP, electronic intercept, and nuclear sampling equipment. These RB-57 aircraft were operated as Project BLACKNIGHT by the 4025th Strategic Reconnaissance Squadron (Light), another unit also part of the 4080th Strategic Reconnaissance Wing (Light). The unit will not be otherwise discussed here, with one exception, because the RB-57s represented an evolutionary "dead end" that SAC soon retreated from in light of the spectacular, but secret, successes of the U-2. The 4025th did serve briefly in doing R&D for nuclear intelligence by conducting sampling missions at the 1958 HARDTACK I test series in the South Pacific.[1274] The 4025th was one of three planned squadrons of the 4080th SRW(L). The other two squadrons, the 4028th and 4029th Strategic Reconnaissance Squadrons (Light) were to implement DRAGONLADY, the unclassified codename for a high-priority effort to add the U-2 to SAC's inventory.[1275] The first orders to the 4080th to initiate DRAGONLADY were issued in December 1956, fast on the heels of the U-2s initial success over the Soviet Union.[1276] In regard to their AFOAT-1 missions, the U-2s initially operated in a separate compartment from the previously described AWS operations. LeMay apparently decided he wanted a piece of the CIA's action, but he chose to concentrate the U-2's mission in the Air Force at this time primarily on nuclear intelligence missions.

The first Air Force U-2s came equipped to conduct photographic and electronic intercept reconnaissance missions, in addition to radioactive debris sampling. With the intent of further obscuring the plane's work, the term "nephography" was coined to refer to the photographic system (Greek, meaning roughly "cloud pictures.") For electronic intercept systems, the term "sferics" was adopted. A historian who joined the unit later had trouble figuring out for himself what all the jargon was about and decided to write a special report clarifying the terms for

---

[1273] 4080th SRW Unit History, August 1956, 1. AFHRA 959-1051. (Note: All AFHRA numbers refer to microfilm acquired from the Air Force Historical Research Agency, Maxwell Air Force Base, Montgomery, Alabama microfilm reel and, if readable, frame number. All microfilm cited is in the possession of the author.)
[1274] 4080th SRW(L) Unit Histories, April to June 1958, AFHRA 961.
[1275] The 4029th SRS(L) remained a paper squadron as far as the author knows and never was activated.
[1276] 4080th SRW(L) Unit History, December 1956, 4. AFHRA 960-0013

posterity, although reading between the lines in the unit histories makes it clear what was involved in each of these mysterious terms.[1277] During the early years of Air Force U-2 operation up until the Cuban missile crisis, "nephography" and "sferics" would play relatively minor, but essential roles, with the idea being that the U-2's could provide electronic reconnaissance and provide post-strike damage assessment so that SAC's bombers could find targets that might still require destruction. The unit was also tasked with "provid[ing] meteorological data from high altitude for operational forecasting," i.e. nuclear sampling.[1278] When the 4080th moved to Laughlin AFB, Texas (outside of Del Rio and just across the Rio Grande River from Mexico) on 1 April 1957, it was feared that even mentioning that the unit was engaged in "weather analysis" was too forthcoming, so it was decided to tell the local media that it was only "a normal SAC light reconnaissance unit."[1279] The obfuscatory terminology, while partially tangential to the current subject matter, was yet another aspect of Air Force information management in the service of secrecy. While waiting for the end of the world, the U-2 would spend the majority of its first half-decade in SAC bolstering the AEDS by flying higher and farther afield than any other nuclear sampler, finally giving the aerial radioactive sampling capability of AFOAT-1 a truly worldwide reach.

"Due to the high priority and classification of the mission of the 4080th SRW, operational control of the Wing was exercised by Headquarters Strategic Air Command direct to the 4080th SRW."[1280] It is hard to state more concretely LeMay's direct, personal interest in the operations of the U-2 than his requiring the 4080th to directly report to his headquarters. He was known as a "hands on" manager and the chain of command designated for the 4080th clearly reflected this fact. Information of this importance needed to flow directly to the top echelon, without being filtered by intermediary levels. LeMay, who had served as SAC commander since 1948, moved up the ladder to the Pentagon in June of 1957, so this order likely also indicated a desire that his successor, General Thomas Power, would retain priority access to the management and results of the 4080th's work.

[1277] Special Report of U-2 Systems, undated, but included in the 4080th SW's Unit History, May 1962. AFHRA 969-453 to 460.
[1278] 4080th SRW Unit History, June 1957, 3. AFHRA 960-679.
[1279] 4080th SRW Unit History, April 1957, 6. AFHRA 960-637.
[1280] 4080th SRW Unit History, April/May 1957, 5. AFHRA 960-636.

Table 4: AFOAT-1/AFTAC Units

Unit#	Location	State/Country	Year Begin	Year End
HQ	Washington DC		1947	?
HQ	Washington DC			
HQ	Washington DC			
HQ	Patrick AFB	Florida		
	Eastern Filed Office	Japan		>1958
?	Southern Field Office	Wiesbaden, FRG	<10 Jul 53	
	Central Field Office	Lindsey AS		>1958
OL-A	Patrick AFB	Florida		<1993
06X	?	?		
7	classified location	?		
45	Buckley AFB, Denver	Colorado		
46	Falcon AFS, Colorado Springs	Colorado		
57	Lowry AFB, Denver	Colorado		
63	?	?		
70	EL Adak	Alaska		
?	Annette Island	Alaska	1951	
72	EL Bermuda	Bermuda		
73	EL Argentia	Newfoundland, Canada		
74	EL Midway			
79	?	?		
101	McClellan AFB, Western Field Office	California	< July 52	
102	Albrook AFB	Canal Zone	< 7 May 54	
103	Hickam	Hawaii	< 7 May 54	
104	Key West (Navy)	Florida	<Oct 50	
105	March AFB	California		
106	McChord AFB	Washington		
OL106	Mather AFB	California	>April 1961	
107	Porto Alegre	Brazil	< 7 May 54	

Table 4: (cont'd)

Unit#	Location	State/Country	Year Begin	Year End
108	Puerto Montt	Chile	<Oct 50	> 7 Apr 55
109	Recife (became Det 213)	Brazil	<Oct 50	> 7 Apr 55
110	Pole Mountain	Wyoming	< 10 Jul 53	30-Dec-58
112	Boston Tracerlab	Massachusetts		
117	Roswell	New Mexico		Mar-63
122	Johnstown	Pennsylvania		13-Aug-51
123	Santiago (see 214)	Chile		
125	Pittsburg, then Edwards AFB	Pennsylvania		13-Aug-53
126	Berkeley, assoc w/ F-101 and G-101	California		
132	Fairchild AFB	Washington		
132	Kindley AFB	Bermuda	< 7 May 54	> 8 Jul 55
135	Centerville Beach	California		
139	Laramie	Wyoming	< 10 Jul 53	15-Dec-58
140	Thule	Greenland	< 10 Jul 53	> 8 Jul 55
141	Douglas	Wyoming	< 10 Jul 53	> 8 Jul 55
142	Encampment	Wyoming	< 10 Jul 53	> 8 Jul 55
143	Ft. Sill	Oklahoma	< 10 Jul 53	> 8 Jul 55
145	St. Nicholas Island, Pt. Mugu	California		
148	Lowry AFB, Denver	Colorado		13-Aug-53
149	Williston	North Dakota		13-Aug-53
151	Chanute AFB	Illinois	< 7 May 54	
152	Chanute AFB	Illinois		
152	Brookley AFB, Delta Field Office	Alabama	< 10 Jul 53	> 7 Apr 55

Table 4: (cont'd)

Unit#	Location	State/Country	Year Begin	Year End
153	?		< 7 May 54	
154	Dow AFB, Limestone?	Maine	< 7 May 54	6-Feb-56
154	Ethan Allen AFB	Vermont	6-Feb-56	
155	Larson AFB	Washington	< 7 May 54	>1963
156	Williamson-Johnson Airport, Duluth	Minnesota	13-Aug-53	1958
157	Lowry AFB, Denver	Colorado		> 8 Jul 55
158	BR Sao Paulo	Brazil	> 8 Jul 55	>1958
159	France AFB, Canal Zone	Canal Zone	> 8 Jul 55	
160	San Angelo	Texas	>55?	
161	Lowry AFB, Denver	Colorado	>1956	
161	Rio de Janier	Brazil	1958	>1958?
162	Pinedale	Wyoming	8-Dec-58	
163	Flin Flon, Manitoba	Canada		
165	Laramie	Wyoming	Apr-59	
170	see 201			
201	Adak	Alaska	<Sep 50	4-May-53
201	Ramey (formerly 170)	Puerto Rico		1-Jul-63
202	Eielson AFB	Alaska	1951	> 8 Jul 55
203	Northern Field Office	Elemendorf AFB (Ft. Richardson)	< 10 Jul 53	<Sep 53
203	Northern Analysis Laboratory	Elemendorf AFB (Ft. Richardson)	Sep-53	> 8 Jul 55
204	Ladd AFB/Fairbanks/Ft. Wainwright	Alaska	< 10 Jul 53	1963?

Table 4: (cont'd)

Unit#	Location	State/Country	Year Begin	Year End
205	Point Barrow, then Shemya	Alaska		
206	Barrow, then to Shemya AFB in '58?	Alaska	Jun-52	
207	Thornborough AFB, then Eielson	Alaska	Jul-52	
208	Annette	Alaska		
209	College	Alaska		
208	Adak	Alaska	>1963	
210	Kodiak	Alaska		<Apr 52
212	Albrook AFB	Panama		>1963
213	Recife {formerly 109)	Brazil		Feb-64
213	Ascension	Island	May-05	
214	Santiago (see 123)	Chile	May-63	Feb-66
215	Ascension	Island	Dec-63	Feb-66
211	Thule	Greenland	Oct-52	
220	Thule	Greenland	Oct-52	< 1957
244	Flin Flon, Manitoba	Canada		>1958
267	Kindley AFB	Bermuda		>1963
271		Alaska?		
301	Ankara/Belbasi	Turkey	< 10 Jul 53	> 1963
?	Teheran/DOORCHECK	Iran	<Aug 51	>1958
304	Dharhan	Saudi Arabia	<1951?	>1956
305	Dharhan	Saudi Arabia		
306	Hanau	FRG	> Fall 53	
308	?	?		
310	Langanes AB	Iceland		May-05
311	"classified location" = Wheelus AFB	Libya	>1963	

Table 4: (cont'd)

Unit#	Location	State/Country	Year Begin	Year End
313	Camp King	FRG	<15 Mar 51	Aug-56
313	Sonseca	Spain	Aug-56	to Spain?
316	Kirkenes	Norway		>1958
317	Keflavik	Iceland	< 7 May 54	> 1963
318	Lajes	Azores, Spain	< 7 May 54	> 8 Jul 55
322	Wheelus Field, Tripoli, Central Field Office	Libya	< 10 Jul 53	> 8 Jul 55
323	Furstenfeldbruck	FRG		1-May-54
323	Camp King	FRG	1-May-54	
324	Asmara	Ethiopia	>Apr 1952	
325	Roberts Field	Liberia		
327	Lahore	Pakistan	15-May-55	11-Jan-63
328	Karamursel	Turkey	<1958	>1963
329	Spieka/Hohes Moor	W. Germany	<1958?	early 1970s
332	Karachi	Pakistan		>1963
	BEAVER	Pakistan	<1958	>1958
347	Caspian Seashore	Iran		>1963
360	EL Keflavik	Iceland		
400	Hickam AFB	Hawaii		>1963
401	Clark AFB	Phillipines	< 7 May 54	> 8 Jul 55
402	Guam	UST	Jan-51	
403	Kadena	Okinawa, Japan	< 7 May 54	> 8 Jul 55
405	Seoul, "Rockpile"	Korea	29-May-52	16-May-58

Table 4: (cont'd)

Unit#	Location	State/Country	Year Begin	Year End
406	Tokyo, Eastern Field Office	Japan	< 10 Jul 53	> 8 Jul 55
407	Yokota AFB	Japan	< 7 May 54	> 8 Jul 55
?	Chitose	Japan		
?	Camp Haugan	Japan	>Fall 53	
408	? (Fuchu AS, Itazuke AB, or Kyoto?)	FEAMCOM	< 7 May 54	
412	Bangkok	Thailand	Oct-63	
413	?	?	< 7 May 54	
414	Kwajalein	Marianas Islands	< 7 May 54	
415	Chiang Mai	Thailand		>1963
416	Hilo	Hawaii		Apr-63
418	John Hay AFB	Phillipines		>1963
421	Alice Springs	Australia	>Apr 55	
422	Misawa AFB	Japan		
423	Del Monte Plantation, Cagayande Oro, Mindanao	Phillipines		
423	EL Guam			
424	Haleakala/Hickam	Hawaii		>1963
426	Perth	Australia	Sep-63	
427	Melbourne	Australia		>1963
428	Anderson AFB	Guam		
430	Woodbourne AS	New Zealand	1963	
433		Pacific Technical Operations Area?		
452	Camp Long, Wonju	South Korea		
459	Pinedale	Wyoming		
460	Eielson AFB	Alaska		
461	Shemya AFB	Alaska		
471				
489	Pinedale	Wyoming		

Table 5: Associated Units

Associated Unit	Locations
1009th Special Weapons Squadron	
1035th Field Activities Group	
1035th Technical Operations Group	
1110th Balloon Activities Squadron	Goodfellow AFB;
1155th Technical Operations Squadron (TCHOS)	
1156th Technical Operations Squadron	
1211th Test Squadron (Sampling)	
1212th Balloon Activities Squadron	Goodfellow AFB;
1970th Communications Squadron	Woomera Air Station, Australia
2059th Air Weather Wing	Tinker AFB, OK
2078th Weather Reconnaissance Squadron	Fairfield-Suisun AFB; Tinker AFB;
20th Helicopter Squadron	
2143rd Air Weather Wing, FEAF	
2107th Air Weather Group	Eielson AFB
308th Weather Group	Tinker AFB;
312th Technical Training Squadron	Goodfellow AFB
3200th Drone Squadron	
3400th Technical Training Wing	Lowry AFB
3454th Technical Training Squadron (SPINSTRA)	Lowry AFB
374th Weather Reconnaissance Squadron	Fairfield-Suisun (Travis) AFB; Nellis AFB (for RANGER)
375th Weather Reconnaissance Squadron (375th SRS(M)W?)	Eielson AFB; Yokota AFB
4025th Strategic Reconnaissance Squadron	
4028th Strategic Reconnaissance Squadron	
4080th Strategic Reconnaissance Wing	Turner AFB; Laughlin AFB; Ramey AFB (Det. 3); Plattsburgh AFB (Det. 4) >
4080th Strategic Reconnaissance Wing [extended]	TDY Ezeiza, Argentina; Australia (1960); Anderson AFB; Albrook AFB; Eielson AFB

Table 5: (cont'd)

Associated Unit	Locations
41st Rescue and Weather Reconnaisance Wing	
4900th Air Base Group	Kirtland AFB;
4901st Air Base Wing	
4901 Support Wing (Atomic)	
4925th Test Group (Atomic)	
4926th Test Squadron (Sampling)	Kirtland AFB; Indian Springs AFB;
4935th Air Base Squadron	Indian Springs AFB;
4950th Test Group (Nuclear)	Kirtland AFB; Indian Springs AFB;
4950th Test Wing	Wright-Patterson AFB
4951st Test Squadron	Wright-Patterson AFB
4952nd Support Squadron (Test)	
512th Weather Reconnaissance Squadron (Very Long Range)	Fairfield-Suisun (Travis) AFB; Yokota AFB; Misawa AFB;
513th Reconnaissance Squadron , Very Long Range, Weather	Tinker AFB; Dharan, SA;
514th Weather Reconnasiance Squadron	North Air Force Base, Guam; Kwajalein
53rd Strategic Reconnaissance Squadron , Medium, Weather	Bermuda
53rd Weather Reconnaissance Squadron	England ('54)
54th Strategic Reconnaissance Squadron , Medium, Weather	Guam
54th Weather Reconnaissance Squadron	
55th Strategic Reconnaissance Squadron , Medium, Weather	Fairfield-Suisun AFB ('49); McClellan AFB
55th Weather Reconnaissance Squadron	Offutt AFB; Ladd AFB; Hickam AFB; McChord AFB;
550th Gudied Missile Wing	Eglin AFB; Eniwetok
561st Fighter Squadron	Bergstrom AFB; Sandia; Indian Springs AFB; Kwajalein;
56th Strategic Reconnaissance Squadron , Very Long Range, Weather	
56th Weather Reconnaissance Squadron	
57th Strategic Reconnaissance Squadron , Medium, Weather	Hickam AFB;

Table 5: (cont'd)

Associated Unit	Locations
57th Weather Reconnaissance Squadron	
58th Weather Reconnaissance Squadron	Kirtland AFB; Alaska ('51)
58th Weather Reconnaissance Squadron	Kwajalein
59th Weather Reconnaissance Squadron, Very Long Range, Weather	
59th Weather Reconnaissance Squadron	Bermuda
6th Strategic Wing	Eielson AFB
6th Strategic Reconnaissance Wing	Eielson AFB
6091st Reconnaissance Squadron	Yokota AFB
6th Weather Squadron (Mobile)	Rongerik, Eniwetok;
7407th Reconnaissance Squadron	Rhein-Main AFB
865th Air Control and Warning Squadron	
9th Weather Reconnaissance Group	
AFOAT (Air Force Assistant for Atomic Energy)	
AFOAT-1 (Air Force Assistant for Atomic Energy)	
AFMSW-1 (AF DCS Materiel, Special Weapons Group, Section One)	
AFSWC (Air Force Special Weapons Command)	
AFSWC (Air Force Special Weapons Center)	
AFSWP (Armed Forces Special Weapons Project)	
AFTAC (Air Force Technical Applications Center)	
AFTAC, Western Field Office	McClellan AFB
AFTAC, Technical Operations Division	McClellan AFB
AWS (Air Weather Service)	
DASA Defense Atomic Support Agency	
DNA Defense Nuclear Agency	
DOD Effects Test Group	
Weather Reconnaissance Squadron Provisional #1	
Weather Reconnaissance Squadron Provisional #2	
WRSP-4	(as Det G > Edwards, as Det G' > Takhli AFB, as Det. H >Taiwan)

Table 6: Sampling and Support Aircraft

Type	Mission	Operations
WB-26	weather recon	tac recon Germany, Japan, ZI
F6F	drone sampler	Crossroads
F-84G	sampler	Tumbler-Snapper, Ivy, Castle
RF-84F	photo recon	Galileo, Tenn. ANG
C-54	courier	AFOAT-1, AFTAC, Ivy to Hardtack II
B-17	sampler drone	Sandstone
WB-29	sampler, wx recon	AWS, Crossroads to Castle
B-50	sampler	Galileo
WB-50D	sampler, wx recon	SAC; AWS, Ranger to 1964 Chinese Shot
T-33	sampler	FEAF, ANG, Buster-Jangle to Hardtack II
WT-33	weather recon	TAC
F-80	drone, drone control	Upshot-Knothole
YC-121F	sampler/trainer	AFTAC
TC-121C	sampler/trainer	AFTAC
H-21	test support	Hardtack II
B-25	courier, sampler	Galielo to Hardtack II
L-20	security	Hardtack II
C-47	courier	AMC, AFTAC, Galileo, SACRED COW
RB-47E	weather recon	AWS
RB-47K	weather recon	SAC
WB-47E	sampler	
HC-130	sampler	ARRS
WC-130	sampler	AWS
B-57B	sampler	AWS, Hardtack II
RB-57D	sampler	AWS, Sunday Punch
RB-57F	sampler	SAC, AWS, Crowflight, Quickdip
U-2	sampler, war plan EMP	SAC
WC-135B	sampler	AWS
TC-135	sampler	SAC
WB-66D	weather recon	TAC
RB-36	weather recon	SAC

Table 6: (cont'd)

B-52	**sampler** (w/pod)	**SAC** SEA FISH high-altitude specials
P-3	weather recon, sampler	Navy
VC-118A	sampler/courier	AFTAC
C-118	sampler	AFTAC
F-4D	sampler w/Genie Air-2A	

Appendix F: Codenames

A quick, if not comprehensive guide to codename identification follows below. Definitions are generally too short for a full description, but are intended as an aid to memory in navigating the text. A few key test shot names are included, but the various cited online references are the best source of complete information on United States, Soviet, British, and other tests.

AQUATONE……………….…U-2 operation by CIA to capture imagery over "denied" territories
BIG SAFARI……….USAF program for acquisition and modification of special mission aircraft
BIT BITE……….program to sample wartime fallout over U.S. to produce fallout prediction data
BLACKKNIGHT……4080th SRW RB-57 program that preceded the later availability of the U-2
BLUENOSE…………….program to study detectable emissions from fissile material production
BRASS RAIL...4080th SRW mission to collect imagery over Cuba from OL X, McCoy AFB, FL
BUDAPEST…..JCS study of impact of fallout from nuclear war on United States military forces
CASTLE BRAVO………………Second U.S. thermonuclear test, fallout incident, 1 March 1954
CODY……………...AFOAT-1 study of use of LRD techniques to assess bomb damage for SAC
CROWFLIGHT………...high altitude sampling done with the U-2 for Project Sunshine, AFSWP
DRAGONLADY…………………………………...SAC program to create operational U-2 units
FITZWILLIAM………..R&D program at SANDSTONE test series, proved long range detection
GABRIEL………………study of fallout's global limits on maximum yield expended in wartime
GENETRIX….drifting from west to east, a balloon-borne imagery collection project over Russia
GREEN RUN..1949 test under BLUENOSE based on large release of reactor effluvia at Hanford
IVY MIKE…………first United States thermonuclear test, conducted in secret, 31 October 1952
JANGLE…………………………...AFOAT-1 test program to verify seismic detection capability
LOON CHARLIE……...Air Weather Service synoptic sampling track between Japan and Alaska
MOGUL……….balloon-borne sonic detection system, crash of one led to Roswell UFO incident
MUSIC……………later name for joint US/UK NOMINATION krypton-85 sampling program
NOMINATION………..joint US/UK krypton-85 sampling program, detected Pu-239 production
SPECIAL…………...sampling mission planned to intercept suspected or identified fallout plume
SPEED LIGHT……………..BIG SAFARI modification of KC-135 to observe "Tsar Bomb" test
TRINITY…………………first ever fission nuclear test, plutonium-239 implosion, 16 July 1945

VELA…………...program to improve AEDS verification capabilities following a partial test ban

VELA UNIFORM……………………………………...seismic improvement program for AEDS

VERMONT………codename assigned to Alert 112, confirmed as Joe-1, first Soviet nuclear test

WHITESNAKE………..Air Weather Service synoptic program for interim network before Joe-1

Bibliography

Adams, Chris. *Inside the Cold War: A Cold Warrior's Reflections*. Maxwell AFB, Alabama: Air University, 1999.

Advisory Committee on Human Radiation Experiments (ACHRE). *The Human Radiation Experiments: Final Report of the President's Advisory Committee*. New York: Oxford University Press, 1996.

Air Force Association staff. "The Clean Weapons Problem." *Air Force*, Vol. 42, No. 12 (December 1959).

Allison, Graham T. *Essence of Decision: Explaining the Cuban Missile Crisis*. New York: Little, Brown, 1971, second edition, with Phillip Zelikow, 1999.

Allison, Helen C. "News Roundup: Radiation Problems." *Bulletin of the Atomic Scientists*, Vol. 15, No. 5 (May 1959).

Alperovitz, Gar. *Atomic Diplomacy: Hiroshima and Potsdam: The Use of the Atomic Bomb and the American Confrontation with Soviet Power*. London: Pluto Press, 1995 edition.

Amrine, Michael. "How to Build a Family Foxhole." *Popular Science Monthly*, Vol. 158, No. 3 (March 1951).

Arkin, William M. *Code Name: Deciphering U.S. Military Plans, Programs, and Operations in the 9/11 World*. Hanover, NH: Steerforth Press, 2005.

Bates, Charles C. and John F. Fuller. *America's Weather Warriors, 1814-1985*. College Station: Texas A&M Press, 1986.

Bethe, Hans. *The Road from Los Alamos*. New York: American Institute of Physics, 1991.

Bernstein, Barton. "Crossing the Rubicon: A Missed Opportunity to Stop the H-Bomb?" *International Security*, Vol. 14, No. 2 (Autumn 1989).

Bernstein, Jeremy. *Nuclear Weapons: What You Need to Know*. New York: Cambridge University Press, 2008.

Bijker, Wiebe E., Thomas P. Hughes, and Trevor Pinch, eds. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge: The MIT Press, 1987.

Bird, Kai and Martin J. Sherwin. *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer*. New York: Knopf, 2005.

Blumberg, Stanley A., and Gwen Owens. *Energy and Conflict: The Life and Times of Edward Teller*. New York: G. P. Putnam's Sons, 1976.

Bogle, Lori Lyn. *The Cold War: National Security Policy Planning from Truman to Reagan and from Stalin to Gorbachev*. New York: Taylor & Francis, 2001.

Boyer, Paul. *Fallout: A Historian Reflects on America's Half-Century Encounter with Nuclear Weapons*. Columbus: Ohio State University Press, 1998.

Boyne, Walter J. "The Early Overflights." *Air Force*, Vol. 84, No. 6 (June 2001), http://www.airforcemag.com/MagazineArchive/Pages/2001/June%202001/0601overfly.aspx.

Boy Scouts of America. *Pattern for Survival: A Guide for Unit Leaders*. New York: Boy Scouts of America, 1951.

Boy Scouts of America. *Family "Be Prepared" Plan*. New York: Boy Scouts of America, 1951.

Bradbury, Ray. *Fahrenheit 451*. New York: Random House/Del Rey, 1953.

Buck, Alice. *The Atomic Energy Commission*. Washington, DC: U.S. Department of Energy, July 1983, http://energy.gov/sites/prod/files/AEC%20History.pdf.

Bulletin staff. "Known Nuclear Tests Worldwide, 1945-1995." *Bulletin of the Atomic Scientists*, Vo. 52, No. 3 (May/June 1996).

Bundy, McGeorge. "Early Thoughts on Controlling the Arms Race: A Report to the Secretary of State, January 1953." *International Security*, Vol. 7, No. 2 (Autumn 1982).

Cabell, Charles P. "Memoirs of an Unidentified Aide." Maxwell AFB, Alabama: Air University, http://www.airpower.maxwell.af.mil/airchronicles/cc/cabell.html.

Cabell, Charles P. *A Man Of Intelligence: Memoirs Of War, Peace, and the CIA: the Memoirs of General Charles P. Cabell*, Charles A. Cabell, Jr., ed, Brigadier General, USAF (Ret), Boulder, CO: Impavide Publications, 1997.

Carter, Donald A. *Forging the Shield: The U.S. Army in Europe, 1951-1962*. Washington, DC: Center for Military History, 2015.

Chernus, Ira. "The Word "Peace" as a Weapon of (Cold) War." http://www.colorado.edu/ReligiousStudies/chernus/4820-ColdWarCulture/Readings/PeaceAsWeaponOfWar.htm

Chernus, Ira. *Apocalypse Management: Eisenhower and the Discourse of National Insecurity*. Stanford: Stanford University Press, 2008.

Clark, Claudia. *Radium Girls: Women and Industrial Health Reform*, 1910-1935. Chapel Hill: University of North Carolina Press, 1997.

Clegg, Brian. *Armageddon Science: The Science of Mass Destruction*. New York: St. Martins Griffin, 2010.

Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council. *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations*. Washington, DC: The National Academies Press, 2003.

Craig, Campbell. *Destroying the Village: Eisenhower and Thermonuclear War*. New York: Columbia University Press, 1998.

Cross, Roger. *Fallout: Hedley Marston and the British Bomb Tests in Australia*. Kent Town, South Australia: Wakefield Press, 2001.

Divine, Robert A. *Blowing on the Wind: The Nuclear Test Ban Debate, 1954-1960*. New York: Oxford University Press, 1978.

Dyson, Freeman. *Weapons and Hope*. New York: Harper & Row, 1984.

Eden, Lynn. *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation*. Ithaca: Cornell University Press, 2004.

Eliot, David C. "Project Vista and Nuclear Weapons in Europe." *International Security*, Vol. 11, No. 1 (Summer 1986).

Evangelista, Matthew. *Unarmed Forces: The Transnational Movement to End the Cold War*. Ithaca: Cornell University Press, 1999.

Evernden, Jack F. "Lies That Stopped a Test Ban." *Bulletin of the Atomic Scientists*, Vol. 44, No. 8 (October 1988).

Farrell, Theo. "Nuclear Non-Use: Constructing a Cold War History." *Review of International Studies, 2010*.

Finston, H.L. and M.T. Kinsley. *The Radiochemistry of Cesium* (NAS-NS-3035). Upton, NY: National Academy of Sciences: National Research Council, 1961.

Fontenot, Jon M. *A New Era: From SAC to STRATCOM*. Quantico: Marine Command and Staff College, undated, http://fas.org/spp/eprint/fontenot.htm.

Foucault, Michel. "Truth and Power." in Noam Chomsky and Michel Foucault. *The Chomsky-Foucault Debates on Human Nature*. New York: The New Press, 2006.

Fowler, John M., ed. *Fallout: A Study of Superbombs, Strontium-90 and Survival*. New York: Basic Books, 1960.

Fradkin, Philip L. *Fallout: An American Tragedy*. Boulder: Johnson Books, 1989.

Friedricjh, Jörg. *The Fire: The Bombing of Germany, 1940-1945*. New York: Columbia University Press, 2006.

Fulghum, David A. "USAF Reconnaissance Comes into Focus." *Aviation Week and Space Technology*, 24 July 2000.

Fuller, John F. *Thor's Legions: Weather Support to the U.S. Air Force and Army, 1937-1987*. Boston: American Meteorological Society, 1990.

Gentile, Gian P. *How Effective Is Strategic Bombing? Lessons Learned from World War II to Kosovo*. New York: New York University Press, 2001.

Georgescu, Calin, with an introduction by Mick Broderick and Robert Jacobs. "United Nations Report Reveals the Ongoing Legacy of Nuclear Colonialism in the Marshall Islands." The Asia-Pacific Journal, Vol 10 Issue 47, No. 1, (19 November 2012).

Gerstell, Richard. *How to Survive an Atomic Bomb*. New York: Bantam Books, 1950.

Getting, Ivan. *All in a Lifetime*. New York: Vantage, 1989.

Glasstone, Samuel, ed. *The Effects of Nuclear Weapons*. Washington, DC: AEC, 1962, 592-5; Nuclear Regulatory Commission, http://www.nrc.gov/reading-rm/basic-ref/glossary/lethal-dose-ld.html. [Although often missing from extant copies, this book included a sleeve with a "Nuclear Bomb Effects Computer" inside the back cover. Among other calculations possible with this circular, slide rule-like device are Initial Nuclear Radiation and Fallout Dose Rates.]

Goodman, Michael S. *Spying on the Nuclear Bear: Anglo-American Intelligence and the Soviet Bomb*. Stanford: Stanford University Press, 2007.

Greene, Benjamin P. *Eisenhower, Science Advice, and the Nuclear Test Ban Debate, 1945-1963*. Stanford: Stanford University Press, 2007.

Grossman, Andrew D. *Neither Dead nor Red: Civilian Defense and American Political Development During the Early Cold War*. New York: Routledge, 2001.

Groves, Leslie M. *Now It Can Be Told: The Story of the Manhattan Project*. New York: Da Capo Press, 1962.

Hacker, Barton C. *Elements of Controversy: The Atomic Energy Commission and Radiation Safety in Nuclear Weapons Testing, 1947-1974*. Berkeley: University of California Press, 1994.

Haight, David G. "Nuclear Testing: A Guide to Historical Holdings in the Dwight D. Eisenhower Library," Eisenhower Library, collection guide.

Hales, Peter Bacon. *Atomic Spaces: Living on the Manhattan Project*. Urbana: University of Illinois Press, 1999.

Hamblin, Jacob Darwin. *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age*. New Brunswick, NJ: The Rutgers University Press, 2008.

Hansen, Chuck. *U.S. Nuclear Weapons: The Secret History*. Arlington, TX: Orion Books, 1988. [cited here as Hansen I]

Hansen, Chuck. *The Swords of Armageddon, Version 2*. Sunnyvale, CA: Chuklea Publications, 2007. [cited here as Hansen II]

Herken, Gregg. *The Winning Weapon: The Atomic Bomb in the Cold War, 1945-1950*. New York: Alfred A. Knopf, 1980.

Hewlett, Richard G. and Francis Duncan. *Atomic Shield: A History of the United States Atomic Energy Commission*. Berkeley: University of California Press, 1990 edition (1962 original).

Hewlett, Richard G. and Jack M. Holl. *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission*. Berkeley: University of California Press, 1989.

Hoddeson, Lillian, Paul W. Henriksen, Roger A. Meade, and Catherine Westfall. *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945*. Cambridge: Cambridge University Press, 1993.

Holloway, David. *Stalin and the Bomb: The Soviet Union and Nuclear Energy, 1939-1956*. New Haven: Yale University Press, 1994.

Hoyt, Edwin P. *Inferno: The Firebombing of Japan, March 9-August 15, 1945*. Lanham, MD: Madison Books, 2000.

International Panel on Fissile Materials. "Global Fissile Materials Report 2010, Balancing the Books: Production and Stocks." http://fissilematerials.org/library/gfmr10.pdf.

Jacobs, Robert. *The Dragon's Tail: Americans Face the Atomic Age*. Amherst: University of Massachusetts Press, 2010.

Jacobs, Robert. "The Radiation That Makes People Invisible: A Global Hibakusha Perspective." *The Asia-Pacific Journal*, Vol. 12, Issue 31, No. 1 (4 August 2014).

Kelley, Robin D.G. *Race Rebels: Culture, Politics, and the Black Working Class*. New York: Free Press, 1996.

Kozak, Warren. *LeMay: The Life and Wars of General Curtis LeMay*. Washington, DC: Regnery, 2009.

Kubrick, Stanley. *Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb*. 1964.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford University Press, 2005.

Lehman, Michael, "Long Half-Life: Government Response to the Environmental Challenge of Radioactive Materials," unpublished research paper, 2002.

Lehman, Michael. "Perishable Secret: Science, Defense Policy, and the Metamorphosis of United States Nuclear Intelligence, 1949-1963." unpublished undergraduate honors thesis, 2003.

LeMay, Curtis. *Mission with LeMay: My Story*, Garden City, New York: Doubleday & Company, 1965.

Libby, Willard. *Worldwide Effects of Nuclear Weapons: Project Sunshine*. Santa Monica: The Rand Corporation, 6 August 1953

Lide, David R. ed. *CRC Handbook of Chemistry and Physics (83rd Edition)*. Boca Raton, FL: CRC Press, 2002.

Lindstrom, Martin. *buy·ology: Truth and Lies About Why We Buy*. New York: Doubleday, 2008.

Lowenhaupt, Henry S. "Mission to Birch Woods." *Studies in Intelligence*, Vol. 12, No. 4 (Fall 1968).

Lowenhaupt, Henry. "Ravelling[sic] Russia's Reactors." *Studies in Intelligence*, Vol. 16, No. 4 (Fall 1972), http://research.archives.gov/description/7283843.

Machta, Lester. "Finding the Site of the First Soviet Nuclear Test in 1949." *Bulletin of the American Meteorological Society*, Vol. 73.

Malloy, Sean L. "A Very Pleasant Way to Die: Radiation Effects and the Decision to Use the Atomic Bombs Against Japan." *Diplomatic History*, Volume 36, Issue 3.

May, Elaine Tyler. *Homeward Bound: Americans Families in the Cold War Era*. New York: Basic Books, 1988.

McEnaney, Laura. *Civil Defense Begins at Home: Militarization Meets Everyday Life in the Fifties*. Princeton: Princeton University Press, 2000.

McClain, Joseph H. "Project East River: The Strategy of Civil Defense." *Bulletin of the Atomic Scientists*, Vol. 9, No. 7 (September 1963).

McMillan, Patricia J. *The Ruin of J. Robert Oppenheimer and the Birth of the Modern Arms Race*. New York: Viking, 2005.

Meilinger, Phillip S. "The Early War Plans." *Air Force Magazine*, Vol. 95, No. 12 (December 2012), http://www.airforcemag.com/MagazineArchive/Pages/2012/December%202012/1212war.aspx.

Mikhailov, V.N., ed. "Catalog of Worldwide Nuclear Testing." http://www.iss-atom.ru/ksenia/catal_nt/intr.htm.

Miller, Joseph L. *Under the Cloud: The Decades of Nuclear Testing*. New York: Free Press, 1986.

Mitchell, Greg. "The Great Hiroshima Cover-Up—And the Greatest Movie Never Made." *The Asia-Pacific Journal: Japan Focus*, http://japanfocus.org/-Greg-Mitchell/3581.

Moody, Walton S. *Building a Strategic Air Force*. Washington, DC: Air Force History and Museums Program, 1995.

Moody, Walton S., Jacob Neufeld, and R. Cargill Hall. "The Emergence of the Strategic Air Command, in "*Winged Shield, Winged Sword: A History of the United States Air Force*, Bernard Nalty, ed. Washington, D.C.: Air Force History and Museums Program, United States Air Force, 1997.

Moore, Leroy. "Lowering the Bar." *Bulletin of the Atomic Scientists*, Vol. 58, No. 3 (May/June 2002).

Morgan, Karl Z. and Ken M. Patterson. *The Angry Genie: One Man's Walk through the Nuclear Age*. Norman: University of Oklahoma Press, 1999.

Morris, Errol. *Fog of War: Eleven Lessons from the Life of Robert S. McNamara*. 2003 movie.

National Academies of Science, Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council. *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations*. Washington, DC: The National Academies Press, 2003, http://www.nap.edu/catalog/10621/exposure-of-the-american-population-to-radioactive-fallout-from-nuclear-weapons-tests.

Nalty, Bernard. *The Air Force and Nuclear Testing, 1958-1964*, Washington, DC: USAF Historical Division Liaison Office, 1965.

Needell, Allan A. *Science, Cold War and the American State*. New York: Routledge, 2000.

Nelson, Robert. “3 Reasons Why the U.S. Senate Should Ratify the Test Ban Treaty.” *Bulletin of the Atomic Scientists*, Vol. 65, No. 2 (March/April 2009).

Oakes, Guy. *The Imaginary War: Civil Defense and American Cold War Culture*. New York: Oxford University Press, 1994.

Ogle, Willaim E. *An Account of the Return to Nuclear Weapons Testing by the United States After the Test Moratorium, 1958*-1961. Washington, DC: U.S. Department of Energy, 1985.

Oppenheimer, J. Robert. “Atomic Weapons and American Policy.” *Foreign Affairs*, Vol. 31, No. 4 (July 1953).

Osgood, Kenneth. *Total Cold War: Eisenhower’s Secret Propaganda Battle at Home and Abroad*. Lawrence: University Press of Kansas, 2006.

Peebles, Curtis. *Shadow Flights: America’s Secret Air War against the Soviet Union*. Novato, CA: Presidio, 2000.

Pedlow, Gregory W. and Donald E. Walzenbach. The *CIA and the U-2 Program, 1954-1974*. Langley: CIA Center for the Study of Intelligence, 2004.

Phillips, Thomas R. “Civil Defense.” *Air Force*, Vol. 38, No. 10 (October 1955).

Pocock, Chris. *50 Years of the U-2: The Complete Illustrated History of the “Dragon Lady.”* Atglen, PA: Schiffer Military History, 2005.

Prados, John. *The Soviet Estimate*. New York, The Dial Press, 1982.

Rhodes, Richard. *The Making of the Atomic Bomb*. New York: Simon & Schuster, 1986.

Rhodes, Richard. *Dark Sun: The Making of the Hydrogen Bomb*. New York: Simon & Schuster, 1995.

Rhodes, Richard. *Arsenals of Folly: The Making of the Nuclear Arms Race*. New York: Knopf, 2007.

Richelson, Jeffrey T. *American Espionage and the Soviet Target*. New York: William Morrow, 1987.

Richelson, Jeffrey T. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York: W.W. Norton, 2006.

Rose, Kenneth D. *One Nation Underground: The Fallout Shelter in American Culture*. New York: New York University Press, 2001.

Rosenberg, David Alan. "Origins of Overkill: Nuclear Weapons and Nuclear Strategy" in *The National Security: Its Theory and Practice, 1945-1960*. Eric Graebner, ed., New York, Oxford University Press, 1986.

Rosenblith, Judy. *Jerry Wiesner, Scientist, Statesman, Humanist: Memories and Memoirs*. Boston: MIT Press, 2003.

Ross, Richard. *Waiting for the End of the World*. New York: Princeton Architecture Press, 2004.

Ross, Stewart Halsey. *Strategic Bombing by the United States in World War Two: The Myths and the Facts*, Jefferson, NC: McFarland & Co., 2003.

Schaffer, Ronald. *Wings of Judgment: American Bombing in World War Two*. New York: Oxford University Press, 1985.

Schake, Kurt Wayne. *Strategic Frontier: American Bomber Command Bases Overseas, 1950-1960*. Trondheim: Historik Institut Det Historisk-Filosofiske Fakultet NTNU, 1998.

Scheibach, Michael. *Atomic Narratives and American Youth: Coming of Age with the Atom. 1945-1955*. Jefferson, NC: McFarland & Co, 2003.

Scott, William B. "USAF Nuclear Detectives Assume New Roles." *Aviation Week & Space Technology*, 3 November 1997.

Scott, William B. "Sampling Mission Unveiled Nuclear Weapon Secrets." *Aviation Week & Space Technology*, 3 November 1997.

Scott, William B. "Debris Collection Reverts to Ground Sites." *Aviation Week & Space Technology*, 3 November 1997.

Seaborg, Glenn. *Kennedy, Khrushchev and the Test Ban*. Berkeley: University of California Press, 1981.

Sherry, Michael S. *The Rise of American Airpower: The Creation of Armageddon*. New Haven: Yale University Press, 1987.

Sherry, Michael S. *In the Shadow of War: The United States since the 1930s*. New Haven: Yale University Press, 1995.

Shibusawa, Naoko. *America's Geisha Ally: Reimagining the Japanese Enemy*. Cambridge: Harvard University Press, 2009.

Shirk, William L., Jr. "Atoms for Peace in Pennsylvania." *Pennsylvania Heritage,* Vol. 35, No. 2 (Spring 2009), http://www.portal.state.pa.us/portal/server.pt/community/history/4569/it_happened_here/471309.

Shute, Nevil. *On the Beach*, New York: Vintage, 2010, original publication date 1957. [Also produced as a 1959 movie by the same title.]

Smith, P.D. *Doomsday Men: The Real Dr. Strangelove and the Dream of the Super Weapon*. New York, St. Martin's Press, 2007.

Snead, David L. *The Gaither Committee, Eisenhower and the Cold War*. Columbus: Ohio State University Press, 1999.

Steiner, Barry H. *Bernard Brodie and the Foundations of American Nuclear Strategy*. Lawrence: University Press of Kansas, 1991.

Stern, Philip M. with collaboration of Harold P. Green, and special commentary by Lloyd K. Garrison, Chief Defense Counsel for Dr. Oppenheimer. *The Oppenheimer Case: Security on Trial*. New York: Harper-Collins, 1969.

Sternglass, Ernest. *Secret Fallout: Low Level Radiation from Hiroshima to Three-Mile Island*. New York: McGraw-Hill, 1981.

Steury, Donald P. ed, *Sherman Kent and the Board of National Estimates*. Washington, DC: Center for the Study of Intelligence, Central Intelligence Agency, 1994.

Strauss, Lewis. *Men and Decisions*. Garden City, NY: Doubleday & Co., Inc., 1962.

Sullivan, William H. *Trilinear Chart of Nuclear Species*. New York: John Wiley & Sons, 1949.

Taubman, Philip. *Secret Empire: Eisenhower, The CIA, and the Hidden Story of America's Space Espionage*. New York: Simon & Schuster, 2003.

Taylor, Lauriston. *Radiation Protection Standards*. Cleveland: CRC Press, 1971.

Taylor, Leland. *History of Air Force Atomic Cloud Sampling*. Kirtland AFB, New Mexico: Historical Division, Office of Information, Air Force Special Weapons Center, Air Force Systems Command, 1963.

Teller, Edward. *Memoirs: A Twentieth-Century Journey in Science and Politics*. Cambridge, MA: Perseus, 2001.

Tibbets, Paul W. *Return of the Enola Gay*. Columbus, OH: Third Coast Marketing, 1998.

Twining, Nathan F. "The Shadow of Air Power at Geneva." *Air Force*, Vol. 38, No. 10 (October 1955)

United Nations Scientific Committee on the Effects of Atomic Radiation. *Sources and Effects of Ionizing Radiation: Sources*. New York: United Nations Publications, 2000, https://books.google.com/books?id=57YmhD4ZBpQC&dq=atmospheric+test+yields&source=gbs_navlinks_s.

U.S. Air Force, Lookout Mountain Laboratory. *Operation SANDSTONE: USAF Participation*. Hollywood: USAF Lookout Mountain Laboratory, 1948 movie.

U.S. Air Force, Lookout Mountain Laboratory. *BUSTER-JANGLE: USAF Participation*. Hollywood: USAF Lookout Mountain Laboratory, 1951 movie.

U.S. Air Force, Lookout Mountain Laboratory. *Operation IVY, Joint Task Force 132, T.G. 132.1 Task Unit Nine, United States Air Force*. Hollywood: Lookout Mountain Laboratory, 1952 movie.

U.S. Air Force, Air Force Technical Applications Center. *A Fifty Year History of Long Range Detection, The Creation, Development, and Operation of the United States Atomic Energy Detection System*. Patrick Air Force Base, Florida: Headquarters, AFTAC, September 1997.

U.S. Atomic Energy Commission. *In the Matter of J. Robert Oppenheimer: Transcript of Hearing before Personnel Security Board and Texts of Principal Documents and Letters*. Forward by Phillip M. Stern, Cambridge: MIT Press, 1971. [cited as ITMO]

U.S. Atomic Weapons Training Group. *Atomic Fundamentals*. Sandia Base/Albuquerque, NM: Field Command, Defense Atomic Support Agency, 1962.

U.S. Centers for Disease Control and National Cancer Institute. *Report on the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations*. Washington, DC, USGPO, 2001, http://www.cdc.gov/nceh/radiation/fallout/.

U.S. Congress Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, *The Nature of Radioactive Fallout and Its Effects on Man*, 27-29 May and 3-7 June 1957, Washington, DC: USGPO, 1957.

U.S. Congress Special Subcommittee on Radiation, Joint Committee on Atomic Energy. *Fallout from Nuclear Weapons Tests, 5-8 May 1959*. Washington, DC: USGPO, 1959.

U.S. Congress Special Subcommittee on Radiation, Joint Committee on Atomic Energy. *Fallout from Nuclear Weapons Tests, Volume 3*. Washington, DC: USGPO, 1959.

U.S. Defense Nuclear Agency, *Operation DOMINIC II: Shots LITTLE FELLER II, JOHNIE BOY, SMALL BOY, LITTLE FELLER I, 7 July - 17 July 1962*, Washington, DC: USGPO, 1962.

U.S. Department of the Army. *Atomic Weapons Employment, No. 39-1*. Washington, USGPO, June 1956.

U.S. Department of the Army. *IVY FLATS Film Report* (MF 20-9811). 1962.

U.S. Department of the Army. *Staff Officers Field Manual: Nuclear Weapons Employment, FM 101-31-3*. Washington: USGPO, Department of the Army, February 1963.

U.S. Department of Energy. *J. Robert Oppenheimer Personnel Hearings Transcripts*. October 2014. https://www.osti.gov/opennet/hearing.jsp. [short title is ITMO2, the substantially complete declassified version of 1954's AEC, *In the Matter of J. Robert Oppenheimer*, ITMO]

U.S. Department of Energy. *Restricted Data Declassification Decisions, 1946 to the Present (RDD-8)*. Germantown, MD: U.S.D.O.E, Office of Health, Safety, and Security, 2002.

U.S. Environmental Protection Agency. "Other Modes of Radioactive Decay." http://www.epa.gov/radiation/understand/positron.htm.

U.S. Federal Radiation Council. *Estimates and Revaluation of Fallout in the United States from Nuclear Weapons Testing*. Washington, DC: U.S.G.P.O., May 1963.

U.S Human Effects Panel Report. "Report to the President and the National Security Council by the Panel on the Human Effects of Nuclear Weapons Development," Dec 1956. https://history.state.gov/historicaldocuments/frus1955-57v19/d96.

U.S Department of State. *Foreign Relations of the United States, 1950, National Security Affairs, Foreign Economic Policy*. Washington, DC: U.S. GPO, 1977.

U.S Department of State. *Foreign Relations of the United States, 1955–1957, Volume XIX, National Security Policy*. Washington, DC: U.S. GPO, 1990.

U.S. Security Resources Panel of the Science Advisory Committee. "Deterrence & Survival in the Nuclear Age." Washington, DC: Office of Defense Mobilization, Executive Office of the President, 7 November 1957, http://nsarchive.gwu.edu/NSAEBB/NSAEBB139/nitze02.pdf. [Gaither Report]

Vandercook, William F. “Making the Very Best of the Very Worst: The ‘Human Effects of Nuclear Weapons’ Report of 1956.” *International Security*, Vol. 11, No. 1 (Summer 1986).

Voss, Earl H. *Nuclear Ambush: The Test Ban Trap*. Chicago: Henry Regnery Company, 1963.

Walker, J. Samuel. *Permissible Dose: A History of Radiation Protection in the Twentieth Century*. Berkeley: University of California Press, 2000.

Wassermann, Harvey and Norman Solomon. *Killing Our Own*. New York: Delta, 1982, http://www.nucleardemolition.com/Killing_Our_Own.pdf.

Watson, Robert J. *History of the Joint Chiefs of Staff, Volume V, The Joint Chiefs of Staff and National Policy, 1953-1954*. Washington, DC: USGPO, 1986.

Weart, Spencer R. *Nuclear Fear: A History of Images*. Cambridge: Harvard University Press, 1988.

Welsome, Eileen. *The Plutonium Files: America's Secret Medical Experiments in the Cold War*. New York: Random House, 1999.

Willis, Jay C. “Report on the History of Fallout Modeling.” Wright-Patterson Air Force Base: School of Engineering, Air Force Institute of Technology, 1979.

Wittner, Lawrence S. *One World or None: A History of the World Nuclear Disarmament Movement through 1953*. Stanford: Stanford University Press, 1993.

Wittner, Lawrence S. *Resisting the Bomb: A History of the World Nuclear Disarmament Movement 1954-1970*. Stanford: Stanford University Press, 1997.

York, Herbert. *The Advisors: Oppenheimer, Teller & the Superbomb*. San Francisco: W.H. Freeman and Company, 1976.

York, Herbert. *Race to Oblivion: A Participants View of the Arms Race*. New York: Simon and Schuster, 1970.

Ziegler, Charles A. "Waiting for Joe-1: Decisions Leading to the Detection of Russia's First Atomic Bomb Test." *Social Studies of Science* 18 (1988), 197-229.

Ziegler, Charles A. and David Jacobson. *Spying without Spies: Origins of America's Secret Nuclear Surveillance System*. Westport, CT: Praeger, 1995.

This page intentionally left blank.